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SCOLECODONTS FROM WELL CORES OF THE MAQUOKETA SHALE, UPPER ORDOVICIAN, ELLSWORTH COUNTY, KANSAS

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Dr. William K. Pooser, Research Geologist of the Cities Service Oil Company, has graciously presented to the Carnegie Museum a suite of 18 scolecodonts for study. The specimens, from Ellsworth County, Kansas, were taken from well cores between 3336 and 3413 feet below the surface and are thought to be from the Maquoketa shale, late Ordovician. Scolecodonts from Ordovician rocks in a number of areas have been studied by various workers: Hinde (1879), Stauffer (1933), Eller (1942, 1945, 1946), Kozlowski (1956), and Zofia Kielan-Jaworowska (1961, 1962). No single species described in this paper can be said to be closely related to any other described Ordovician forms. All the specimens are very small, being less than a half-millimeter in size. If the surface outcrops, together with cores from a number of wells of the Maquoketa formation were examined, it is likely that scolecodonts would be found in relative abundance. Detailed studies at numerous localities and stratigraphic horizons could be beneficial to biostratigraphers.

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Genus Lumbriconereites Ehlers, 1868

Lumbriconereites inconditus, new species

Maxilla I, figures 1-3

Irregular lateral margins are distinctive characteristics of the narrow and elongate jaw. A series of twelve conical, sharp-pointed to rounded, medium-sized, backward-directed denticles extends along

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the inner margin nearly to the posterior end. The first denticle, or fang, is long, sharp-pointed, and somewhat hooked. Most of the denticles are fairly uniform in size and all are oblique to the under side of the jaw. Part of the posterior end of the jaw is missing but it probably tapered to a small rounded extremity. The margins of the jaw are irregularly curved and form small flange-like projections. About one-half of the upper surface is occupied by a deep fossa, which extends from about the mid-area of the jaw to the posterior end. The margins of the fossa are slightly thickened and rounded. Both the upper and under sides of the jaw are irregularly convex and concave.

A number of species of *Lumbriconereites* are similar in a general way to *Lumbriconereites inconditus*. They differ mostly in the outline of the margins and the size of the fossa.

Lumbriconereites dissimilaris, new species

Maxilla I, figures 4, 5

The jaw is elongate and narrow. On first examination the narrowness of the specimen suggested that part of the jaw along the outer margin is missing. Since the margin of the fossa seems to be complete and regular, the impression is probably due to the irregular curving of the margin at various places. Along the inner margin a series of eighteen large, blunt or rounded denticles extends the full length of the jaw. They are oblique to the surface of the jaw. The fang, or first denticle, is large, narrow, and sharp-pointed, and is directed forward. The second denticle is blunt and is also directed toward the anterior. The remaining denticles are more or less perpendicular to the inner margin and decrease in size uniformly to small ones at the posterior end. A large rounded flange at about the middle of the jaw curves in slightly to form a shallow bight. A small, shallow fossa occupies about one-third of the flange and extends to the narrow, rounded, posterior extremity. The margins of the fossa, especially the outer one, are thickened and rounded. The surfaces of the jaw are convex except for a narrow area on the under side of the jaw at the posterior half, which is concave.

Except for the narrowness of the jaw at the anterior half, and the small fossa, *Lumbriconereites dissimilaris* is typical of the genus and can be compared to a number of forms in a general way. It is, however, dissimilar to any other species.

Lumbriconereites machinosus, new species

Maxilla I, figures 6, 7

When viewed from the under side the surface of the jaw is irregularly concave and convex. Along the inner margin a series of eleven conical-to-rounded denticles extends for more than three quarters of the length of the jaw. The first denticle or fang is large. long, and points nearly in a forward direction. The second tooth is similar but smaller and is separated from the first and third denticles by a space. Beginning with the third, the denticles are large, wide, rounded, short, and very close together. The teeth increase in size to about the middle of the jaw where they then decrease gradually in size toward the posterior. The denticles are slightly oblique to the under surface of the jaw. From the fang the irregularly curved outer margin forms a small shank and a bight and then recurves to a narrow, knob-like posterior extremity. A large deep fossa occupies more than one-half of the upper surface of the jaw. The margins of the fossa are well-rounded and thickened. A narrow elongate flange is present on the inner margin of the jaw. The surface of the jaw anterior to the fossa is convex.

The right jaw of *Lumbriconereites machinosus* is similar to those in a number of specimens of the genus. These jaws differ mostly in the type, arrangement, and obliqueness of the denticles. There is a slight resemblance between *Lumbriconereites machinosus* and *Lumbriconereites perpentatus* Hinde (1822: fig. 68). Except for the denticles and their curved arrangement and a wider flange, *Lumbriconereites proclivis* Eller (1942) is like *Lumbriconereites machinosus.* Two forms, *Lumbriconereites tuberosus* Eller (1945) and *Lumbriconereites jenningsi* Eller (1945), are like *Lumbriconereites machinosus* in certain ways but differ in the type and arrangement of the denticles and in other details of structure. *Lumbriconereites celsus* Eller (1961) is similar, generally, to *Lumbriconereites machinosus,* especially in the form and position of the first and second denticles. They are unlike in the position of the shank and in other characteristics.

Lumbriconereites attactus, new species

Maxilla I, figures 8, 9

The jaw is elongate and rounded at the anterior and posterior ends. A series of 17 long, narrow, conical, closely arranged, sharp-pointed,

backward-directed denticles extends nearly the full length of the jaw. The first denticle is larger than the remaining teeth, which decrease in size only slightly to the posterior. A large, curved shank extends nearly the full length of the jaw. The margin of the shank may be broken. On the upper surface a large, shallow fossa occupies about three-quarters of the jaw. The margins of the fossa are slightly thickened and rounded. The upper surface of the jaw is convex and the under surface is nearly flat.

This form does not compare very closely with other species of the genus. The left jaw of *Lumbriconereites hibbardi* Eller (1940) resembles *Lumbriconereites attactus* in a general way. The two species differ mostly in the shape and arrangement of the denticles and the shape of the shank. Hinde (1879) described a form as *Eunicites clintonensis* that is probably a side-view of a *Lumbriconereites* species. It is similar to the side-view of *Lumbriconereites attactus* but differs in the width of the posterior end and the length of the denticles.

Genus *Paleoenonites* Eller, 1942

Paleoenonites discrepans, new species

Maxilla II, figure 10

This form varies considerably from other species of the genus because of the position of the shank. It begins at the mid-area of the jaw instead of in the anterior part. The jaw is elongate with an acute posterior extremity. Along the inner margin a series of eight conical, sharp-pointed, backward-directed denticles extends for about two-thirds the length of the jaw. The first denticle or fang is large, pointed, and separated from the second tooth by a space. The remaining denticles are nearly uniform in size and are slightly oblique to the under surface of the jaw. A shallow-to-deep irregular fossa occupies more than half the upper surface of the jaw. The margins of the fossa are thickened and rounded. The outer margin curves gently from the anterior and then curves in to form a large, angular shank that curves slightly to the posterior end. The upper surface of the jaw is irregularly concave. The under surface is irregularly concave and convex.

Paleoenonites discrepans has characteristics found in a number of species of the genus but does not compare very closely with any of them in the position of the shank and fossa and the absence of denticles at the posterior end. The form might be grouped with *Paleoen-*

onites acutus Eller (1945), *Paleoenonites circumscriptus* Eller (1945), *Paleoenonites armigerus* Eller (1955), and *Paleoenonites davisae* Eller (1945).

Paleoenonites infundibulus, new species

Maxilla II, figure 25

In outline, the jaw is subtriangular, wide anteriorly, and the lateral margins taper to an acute posterior extremity. Along the inner margin a series of fourteen sharp-pointed, conical, backward-directed denticles extends the full length of the jaw. The first denticle, or fang, is large, forward-directed, and only slightly hooked. From the fang the denticles increase in size very slightly to the mid-area and then decrease in size gradually to the posterior end. The anterior margin is fairly straight, but at the outer end curves abruptly with the curved outer margin to form a small, round, shank-like projection. The surface of the jaw is irregularly convex and concave. Since matrix covers the upper side of the jaw the fossa cannot be seen and described.

A number of species of *Paleoenonites* resemble *Paleoenonites infundibulus*. If the fossa of the specimen could be observed, this form might prove to be the same as *Paleoenonites acutus* Eller (1945). The denticles and the shank, or area at the anterior end, are slightly different in the specimens of the two species. *Paleoenonites accuratus* Eller (1942) resembles *Paleoenonites infundibulus* except at the posterior end. With the exception of the number of denticles and the contour of the outer margin, *Paleoenonites latissimus* Eller (1942) is similar to *Paleoenonites infundibulus*. Two species, *Paleoenonites kopfi* Eller (1940) and *Paleoenonites fornicatus* Eller (1940), are comparable to *Paleoenonites infundibulus*. A form, *Oenonites radula* Hinde (1882), from Gotland, is similar to *Paleoenonites infudibulus*, especially in the shape of the fang and denticles and their arrangement. Eller (1964) described a form, *Paleoenonites lacinatus*, that resembles *Paleoenonites infundibulus*, but only in a general way.

Genus *Ildraites* Eller, 1936

Ildraites infractus, new species

Maxilla I, figures 11, 12

Part of the posterior end of this specimen is missing. The jaw is elongate and subtriangular in shape. Along the nearly straight inner

margin a series of eleven conical, blunt and sharp-pointed, backward-directed denticles extends the full length of the jaw. In the complete specimen there might have been two or three more teeth in the series. The first denticle is fairly heavy, pointed, slightly curved, and directed forward. The second denticle is blunt and thickened. All the teeth are slightly oblique to the under-surface of the jaw. The outer margin curves in from the rounded anterior end and the fang to form a large, triangular-shaped shank with a fairly acute point. A rather shallow bight is formed by the shank and the nearly straight outer margin of the posterior area of the jaw. On the upper side of the jaw a large, fairly deep fossa occupies about one-half of the surface. The margins of the fossa seem to be slightly thickened and rounded. The concavity and convexity of the under-surface of the jaw are barely perceptible. The upper side is definitely convex.

Ildraites infractus cannot be compared very closely with most forms described under this genus. The narrowness of the jaw, the curve of the outer margin, the forward-directed fang, and the shape and size of the second denticle make the form unlike other species. Stauffer (1933) described *Eunicites granus*, which, except for the two small denticles following the fang, appears to be similar to *Ildraites infractus*. *Ildraites bowenensis* Eller (1941) closely resembles *Ildraites infractus*. They differ in the position of the first denticle and the size and shape of the second tooth. Loranger (1963) figured *Ildraites bowenensis* from Alberta. It may be compared to *Ildraites infractus*. A form, *Ildraites eminulus* Eller (1963), resembles *Ildraites infractus* in a general way. The differences usually occur in the anterior part. The fang and the arrangement of the anterior denticles are dissimilar.

Ildraites pooseri, new species

Maxilla I, figures 13, 14

This form has a very small fang, or first denticle, and there is not much space between it and the second denticle. The jaw is wide anteriorly but decreases abruptly at about the midpoint to form a narrow posterior area and lateral margins that are nearly parallel. On the gently curved inner margin a series of eleven, rather large, blunt, conical, backward-directed denticles extends nearly to the truncate posterior extremity. The fang is narrow, well hooked, and slightly oblique to the under surface of the jaw. The first four denticles follow-

ing the fang are not as blunt as the remaining ones, and not as oblique to the surface of the jaw. From the first denticle the outer margin curves gently and then curves in slightly to form a heavy truncate shank. A wide, shallow bight emphasizes the shortness of the shank. The fossa is narrow and irregular in shape and extends from the anterior end of the shank to the posterior extremity of the jaw. In the area of the shank the fossa is wide, then narrows abruptly for most of the length of the jaw and again becomes wide at the posterior. The margins of the fossa are thickened and rounded. The upper surface is irregularly convex. The under surface is mostly concave except for narrow ridges extending lengthwise to the jaw.

Stauffer (1939) described a form, *Arabellites dauphinensis,* that, with the exception of the shank, is slightly similar to *Ildraites pooseri* in general shape. *Ildraites howelli* Eller (1941; Sylvester, 1959) resembles *Ildraites pooseri* in a number of characteristics but differs in the shape of the shank and fossa. *Ildraites pooseri* is like *Ildraites bowenensis* Eller (1941; Loranger, 1963) in a number of ways. The two differ in the shape of the fossa and in the space between the first and second denticles. There is a slight resemblance between *Ildraites eminulus* Eller (1963) and *Ildraites pooseri.*

Ildraites cyclus, new species

Maxilla I, figure 22

The jaw is elongate and narrow, especially in the posterior area. Along the nearly straight inner margin a series of fourteen rounded, closely arranged denticles extends for about three-fourths of the length of the jaw. The first denticle, or fang, is large and is followed by three small teeth of uniform size. The fifth denticle is larger, and the teeth increase in size to about the mid-area, where they begin to decrease uniformly in size to the posterior. The denticles are slightly oblique to the under side of the jaw. From the fang the outer margin is rounded and then incurved to form a large, semi-rounded shank. The posterior margin of the shank is nearly straight and forms an angular bight with the straight outer margin. A deep fossa occupies the area of the shank and the narrow posterior end. The margins of the fossa are slightly thickened and rounded. The under surface of the jaw is mostly convex except at the anterior end.

A form, *Ildraites exquisites* Eller (1942), is similar to *Ildraites cyclus* except for the size and shape of the shank and the type and

EXPLANATION OF PLATES

Figures magnified about 50 times. Numbers in parentheses are Carnegie Museum catalogue designations of the respective type specimens.

Figs. 1, 2, 3. *Lumbriconereites inconditus,* new species, Maxilla I (30299). Subsurface level, 3336 ft.

Figs. 4, 5, *Lumbriconereites dissimilaris,* new species, Maxilla I (30300). Subsurface level, 3410 ft.

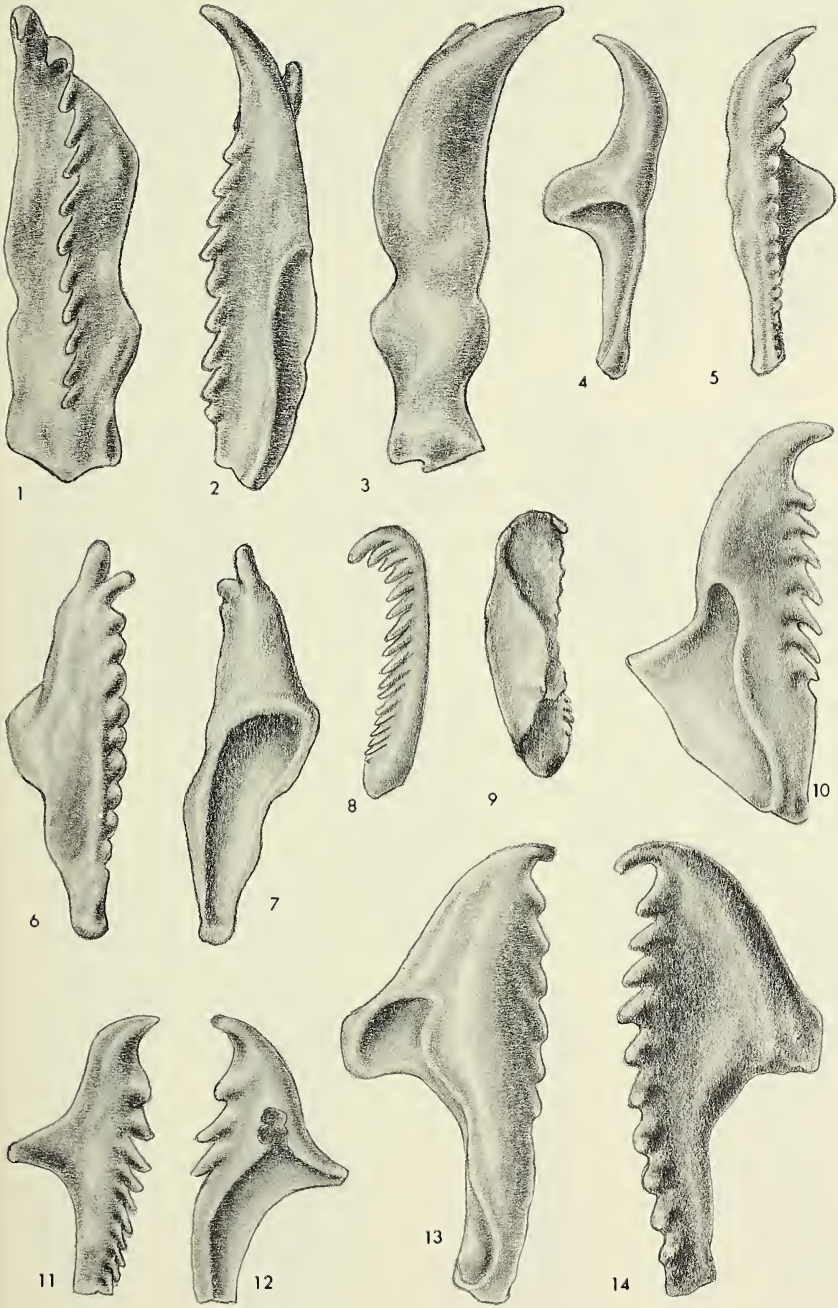
Figs. 6, 7, *Lumbriconereites machinosus,* new species, Maxilla I (30301): Subsurface level, 3340 ft.

Figs. 8, 9. *Lumbriconereites attactus,* new species, Maxilla I (30302). Subsurface level, 3414 ft.

Fig. 10. *Paleoenonites discrepans,* new species, Maxilla II (30303). Subsurface level, 3414 ft.

Figs. 11, 12. *Ildraites infractus,* new species, Maxilla I (30305). Subsurface level, 3410 ft.

Figs. 13, 14. *Ildraites pooseri,* new species, Maxilla I (30306). Subsurface level, 3414 ft.


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Figs. 15, 16. *Leodicites interstrictus,* new species, Maxilla II (30309). Subsurface level, 3414 ft.

Fig. 17. *Staurocephalites apicatus,* new species, Maxilla II (30310). Subsurface level, 3412 ft.

Figs. 18, 19. *Nereidavus novenus,* new species, Maxilla I (30313). Subsurface level, 3425 ft.

Figs. 20, 21. *Staurocephalites ellsworthensis,* new species, Maxilla II (30311). Subsurface level, 3412 ft.

Fig. 22. *Ildraites cyclus,* new species, Maxilla I (30307). Subsurface level, 3410 ft.

Figs. 23, 24. *Ildraites limatus,* new species, Maxilla I (30308). Subsurface level 3412 ft.

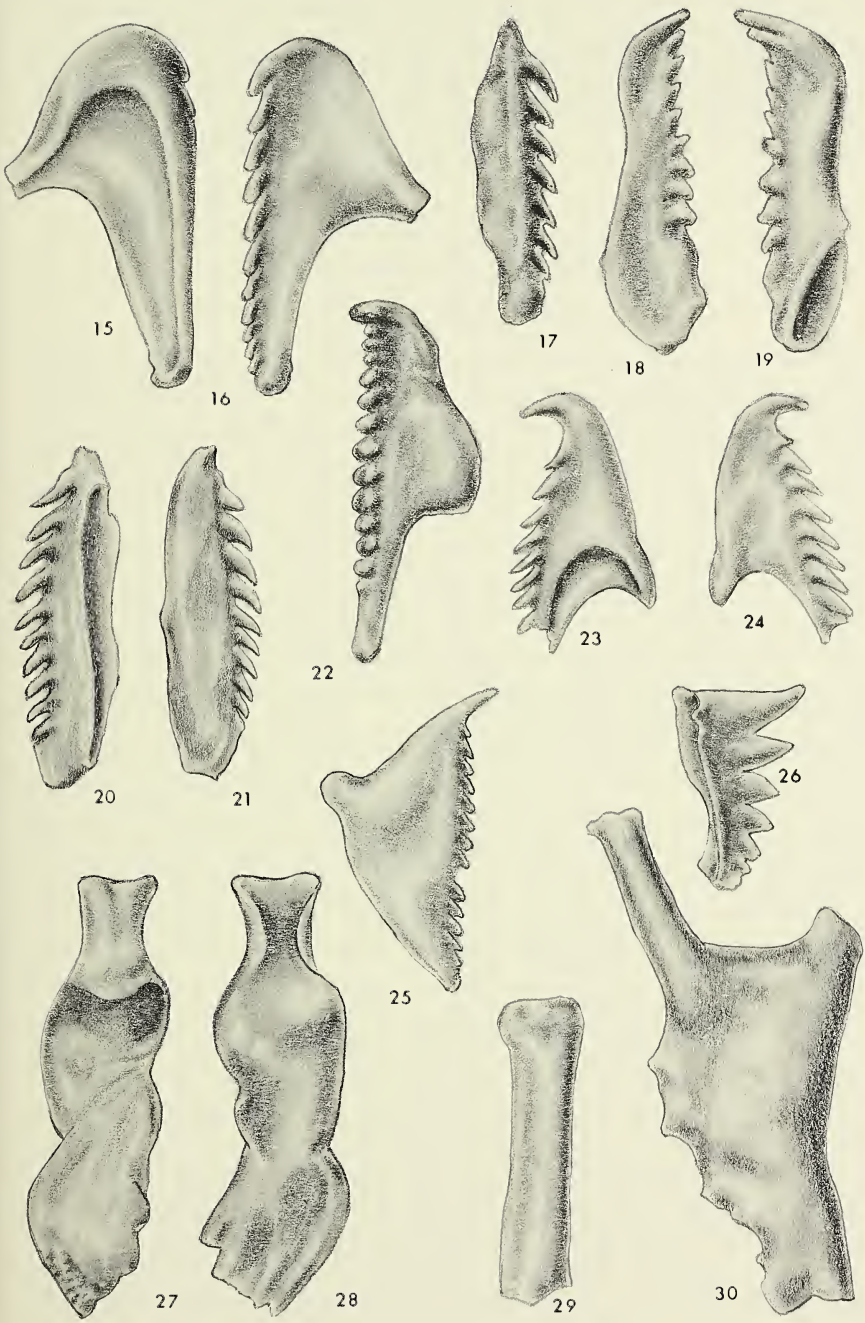
Fig. 25. *Paleoenonites infundibulus,* new species, Maxilla II (30304). Subsurface level, 3340 ft.

Fig. 26. *Staurocephalites invisitatus,* new species, Maxilla II (30312). Subsurface level, 3340 ft.

Figs. 27, 28. *Marphysaites multiformis,* new species, Carrier? (30314). Subsurface level, 3340 ft.

Fig. 29. *Marphysaites claviger,* new species, Carrier (30315). Subsurface level, 3410 ft.

Fig. 30. *Siluropelta crassecaulis,* new species, Mandible (30316). Subsurface level, 3412 ft.


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arrangement of the denticles. *Ildraites fritzae* Eller (1942) has the narrow, elongate, posterior end, like *Ildraites cyclus.* The shape of the bight and the type and arrangement of the teeth are different, however.

Ildraites limatus, new species

Maxilla I, figures 23, 24

In shape the jaw is elongate and subtriangular. Along the slightly curved inner margin a series of nine, long, conical, sharp-pointed, backward-directed denticles extends the length of the jaw. The posterior end of the jaw is missing and it is possible that there may have been two or more additional denticles in the series. The fang, or first denticle, is large, well hooked, and slightly oblique to the under surface of the jaw. When viewed from the under side the impression is that there is not as much space between the first and second denticles as there actually is. The second denticle is small and is followed by teeth that increase in size to about the middle of the jaw and then decrease slightly in size to the posterior. The outer margin curves gently from the fang and then curves in slightly to form a medium-sized, fairly acute shank. A shallow, crescent-shaped bight on the outer margin forms the curved posterior margin. A rather small fossa occupies the posterior part of the jaw. The margins of the fossa are slightly thickened and rounded. The under surface of the jaw is irregularly convex and concave, and the upper side is mostly convex.

A number of forms of the genus *Ildraites* may be compared with *Ildraites limatus* in certain details, but none of the forms resembles it closely. *Lumbriconereites expansus* Stauffer (1939) and *Eunicites grandis* Stauffer (1939) have similar characteristics. They differ mostly in the type and arrangement of the denticles. *Ildraites bowenensis* Eller (1941; Loranger, 1963), resembles *Ildraites limatus* closely except for the width at the anterior end and the size of the fossa. Except for the denticles and the shape of the anterior area, *Ildraites howelli* Eller (1941); Sylvester, 1959), is similar to *Ildraites limatus* in a general way. There is a slight resemblance between *Ildraites patulus* Eller (1942) and *Ildraites limatus.* The narrowness of the anterior area and the type of denticles of *Ildraites rarus* Eller (1945) and *Ildraites limatus* are comparable. *Ildraites appressus* Eller (1955) is like *Ildraites limatus* except for the number and arrangement of the

denticles. *Ildraites eminulus* Eller (1963) and *Ildraites limatus* are fairly similar except for the space between the first and second denticles and the width of the anterior and posterior ends. *Ildraites unexspectatus* Eller (1964) has characteristics akin to *Ildraites limatus.* They differ mostly in the size of the fossa.

Genus *Leodicites* Eller, 1940

Leodicites interstrictus, new species

Maxilla II, figures 15, 16

A small part of the shank, unfortunately, is missing from this form. The jaw is elongate and subtriangular in outline. Along the nearly straight inner margin a series of eleven blunt, conical denticles extends nearly to the narrow, rounded, posterior extremity. The denticles are uniform in shape and decrease gradually in size to the posterior. All the teeth are directed backwards and appear to overlap each other. The anterior margin is broadly rounded from the first denticle and then incurved slightly to form a shank that is probably nearly straight. A deep crescent-shaped bight on the outer margin emphasizes the length of the shank. A large fossa is present on the upper side of the jaw. The margins of the fossa are slightly thickened and rounded. In the center of the fossa a convex ridge extends from the posterior to about the center of the jaw. This convexity is reflected by a concave area on the under side of the jaw.

Although *Leodicites interstrictus* is typical of the genus it is not very similar to other forms. There is a slight resemblance to *Leodicites variedentatus* Eller (1940), *Leodicites reimanni* Eller (1941), and *Leodicites altilis* Eller (1955). The form differs mostly in details of its general shape and in the type and arrangement of the denticles.

Genus *Staurocephalites* Hinde, 1879

Staurocephalites apicatus, new species

Maxilla II, figure 17

The jaw is narrow and elongate with a pointed anterior end and a rounded posterior extremity. A nearly straight inner margin bears a series of eight large, conical sharp-pointed, backward-directed denticles, which extends to the posterior. The first denticle is slightly larger than the remaining teeth, which decrease in size uniformly. A

large fossa extends from the first denticle to the posterior area. The inner margin of the fossa is thickened; the outer margin is thin. The under surface of the jaw is irregularly concave and convex. A narrow ridge extends the full length of the jaw on the under side.

Staurocephalites dentatus Stauffer (1933), *Staurocephalites heppenstallae* Eller (1945), and *Staurocephalites mccallae* Eller (1945) resemble *Staurocephalites apicatus* in a general way. They differ mostly in the number of denticles and the shape of the anterior end.

Staurocephalites ellsworthensis, new species

Maxilla II, figures 20, 21

In outline the jaw is elongate and in shape semiovate, with the broader end at the posterior. On the slightly curved inner margin a series of ten large, conical, sharp-pointed, backward-directed denticles extends nearly the full length of the jaw. The first denticle is slightly larger than the remaining teeth, which decrease in size uniformly to the posterior. A narrow fossa extends from opposite the first denticle nearly to the posterior end of the jaw. The inner, or upper, margin of the fossa is thickened and rounded; the outer margin is thin. The anterior end of the jaw is missing but it probably terminated in an acute ending. The posterior end of the jaw is broad and truncate. The under side of the jaw is irregularly convex and concave. The upper surface is mostly convex.

There is a general resemblance of *Staurocephalites dentatus* (Stauffer (1933), *Staurocephalites mccallae* Eller (1945), and *Staurocephalites heppenstallae* Eller (1945) to *Staurocephalites ellsworthensis.* They differ mostly in the anterior area and in the number and type of denticles.

Staurocephalites invisitatus, new species

Maxilla II or III, figure 26

There is a section missing from the posterior end of the jaw, but it is probably very small since the last denticle is minute in size. The jaw is small and subtriangular in shape. Along the inner margin a series of seven, very large to very small, conical, sharp-pointed denticles extends the full length of the jaw. The first denticle points slightly forward and the remaining teeth are nearly perpendicular to

the margin. A narrow, deep fossa occupies the full length of the jaw. At the anterior end of the fossa are two small spurs. The margins of the fossa are slightly thickened and rounded. The upper surface of the jaw is mostly concave and the under surface is convex.

Staurocephalites invisitatus is unlike most species of the genus. Except for the length and size of the denticles, *Staurocephalites kayi* Eller (1945) slightly resembles *Staurocephalites invisitatus.*

Genus *Nereidavus* Grinnell, 1877

Nereidavus novenus, new species

Maxilla I, figures 18, 19

When viewed from different sides, the outline of the jaw varies in shape. It is generally elongate and narrow. On the inner margin a series of nine conical denticles extends for nearly three-quarters of the length of the jaw. The fang is long, narrow, and is directed forward. It is followed by a smaller, similar tooth that is in close contact with the fang. The next four denticles are fairly uniform in size and point anteriorly. The remaining three teeth are larger and directed backward. A deep, oval fossa occupies about two-fifths of the posterior area of the jaw. The margins of the fossa are thickened and rounded. The upper side of the jaw is convex and the lower side is irregularly concave and convex.

Usually the fossa and the posterior end of the right jaw of *Nereidavus* species are irregular in shape and contour. Flanges are usually present. This form lacks the usual central ridge in the fossa which is reflected on the under side by a depressed area. The form and arrangement of the denticles are similar in a number of *Nereidavus* species. The right jaw of *Nereidavus invisibilis* Eller (1940) is similar to that of *Nereidavus novenus* in shape but differs in the denticles and in the complexity of the fossa. *Nereidavus hamulus* Eller (1941) has an uncomplicated fossa like that of *Nereidavus novenus.* All four species are unlike in the shape of the posterior end, and in number and arrangement of the denticles.

Genus *Marphysaites* Eller, 1945

?Marphysaites **multiformis,** new species

Carrier? figures 27, 28

It is not certain whether this specimen is a carrier or actually part of a jaw apparatus. Although there is a general resemblance of the

form to carriers of modern and fossil species no illustration has been found in which the carriers were structurally as complex as this one. Unlike this specimen, the illustrations show a nearly straight inner margin in articulation with the margin of the other carrier. It is difficult to know which is the upper or under surface of the specimen. In shape the form is elongate, with irregularly curved margins. A portion of the posterior end is probably missing. The anterior end is truncate and slightly incurved, appearing to provide a natural place for articulation with a maxilla. If figure 28 is the upper side, the lateral rounded margins are bent inward and form a tube-like area. The purpose of this hollow may be to accommodate a muscle or a part of the maxilla. On the opposite side is a deep fossa-like area with a curved lip-like anterior margin. The surface of the specimen is irregularly convex and concave with round and elongate depressions and ridges.

Marphysaites claviger, new species

Carrier, figure 29

In outline the carrier is elongate and narrow with parallel margins. The anterior end is truncate with a slightly incurved margin. The posterior end may be broken. A ridge, which is forked near the anterior, extends the full length of the specimen to the posterior where it curves to the left. Adjacent to the ridge on the left side is a long depressed area. At the anterior end of the form are three depressions.

Marphysaites claviger is unlike other forms of the genus. It differs mostly in the sculpture of the surface and in the shape of the anterior end. Eller (1945) described *Marphysaites aptus* as a mandible based on the resemblance to species of the modern genus *Marphysa.* In 1964, however, Eller described two species, *Marphysaites junctus* and *Marphysaites gomphoides,* as carriers since the anterior margin of these species appeared to be the probable articulating surface with the posterior end of a maxilla I. The carrier *Marphysaites claviger* resembles some of the carriers of the modern genus *Leodice* Savigny.

Genus *Siluropelta* Eisenack, 1939

Siluropelta crassecaulis, new species

Mandible, figure 30

In shape the mandible is wide with an irregular (probably broken) outer and posterior margin. The inner margin is slightly incurved instead of being nearly straight as in most species. In the articulation

there is probably an overlapping with an adjacent mandible. The anterior margin curves in slightly and at the outer margin forms a long, thick, rounded shaft or spine that terminates in a knob-like ending. A small projection is present at the inner margin of the anterior end. The surface of the mandible is mostly concave with some ridges and raised areas.

Siluropelta crassecaulis does not resemble other species of the genus very closely.

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REPORTS ON THE MARGARET M. CARY-CARNEGIE MUSEUM EXPEDITION TO BAJA CALIFORNIA, MEXICO, 1961

5. Two new subspecies of Hesperiidae (Lepidoptera) from the Cape region, Baja California Sur, Mexico

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and

C. Don MacNeill

Division of Natural Sciences, Oakland (California) Museum

This is the fifth of a series of papers based on the Margaret M. Cary-Carnegie Museum Expedition to Baja California, Mexico, 1961, to appear in the Annals of Carnegie Museum. For an account of the itinerary and description of localities, see the first paper in this series [Richard M. Fox, Ann. Carnegie Mus., 36 (16): 181-192]. Except as noted, all specimens including type series are in the collection of Carnegie Museum.

In his review of the Hesperiidae of Baja California one of us (MacNeill, 1962) recognized the existence of endemic subspecies of three Cape region hesperiids *Cogia hippalus* (Edwards), *Polites sabuleti* (Boisduval), and *Paratrytone melane* (Edwards) — but did not name them because there was not enough material. As a result of the collections made by the Cary-Carnegie Expedition, good series are now at hand to describe subspecies of *Cogia hippalus* and *Polites sabuleti*. The montane *Paratrytone melane* population was not taken.

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Cogia hippalus peninsularis, new subspecies

Figures 1 (male holotype), 2 (female paratype), 7 (male genitalia)

MALE: Head, thorax, and abdomen brown above, paler below. Palpi dark brown above and pale gray below. Antennae brown above, shaft yellow below, ringed with brown; club completely encircled with brown basad of nudum. Legs scaled with light brown. Upper surface of wings much like *C. h. hippalus* (Edwards), but the spots on the forewings are larger, particularly those in spaces M_3-Cu_1 and Cu_1-Cu_2, which often are as broad as they are long. On the under surface of the hindwings the dark bands are very broad and often connected in space Cu_1-Cu_2. This connection is never present in specimens of the nominate subspecies. There is no whitish bloom marginad of the discal band on the hindwings beneath in *C. h. peninsularis*. This band is characteristic of *C. h. hippalus*. The fringes of the forewings are grayish-brown with dark-brown checkering at the ends of the veins, paler gray near the anal angle. The fringes of the hindwings are whitish, completely interrupted by dark-brown checkering. The male genitalia are indistinguishable from those of *C. h. hippalus*. Length of the forewing of the male holotype is 19.0 mm.; the forewings of the eighteen male paratypes range from 19.0 to 23.0 mm., averaging 20.2 mm.

FEMALE: Generally differs from *C. h. hippalus* in the same particulars as does the male. The forewing cell spots of one specimen are divided like Arizona specimens of the nominate subspecies. In all other specimens of *C. h. peninsularis* these spots are conjoined. The dark bands of the hindwings beneath, while broader than those of mainland material, are not as broad as in the males and never connected across space Cu_1-Cu_2. Lengths of the forewings of the five female paratypes range from 19.0 to 23.0 mm., averaging 21.2 mm.

Described from 24 specimens, 19 males, and five females, from the Cape region of Baja California Sur and the adjacent island of Espiritu Santo.

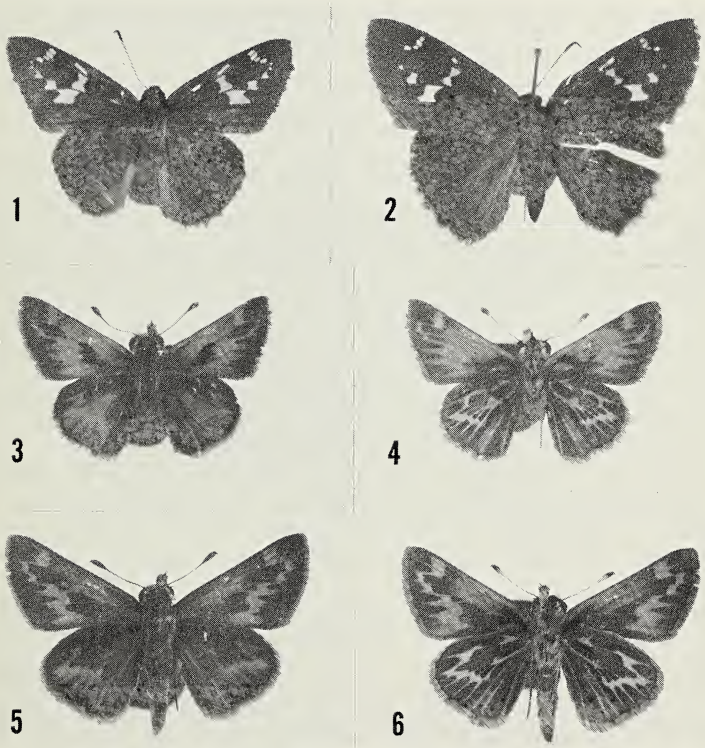
HOLOTYPE MALE: Mexico: Baja California Sur: Arroyo San Bartolo, Nov. 3, 1961, Cary-Carnegie Expedition (Lee D. Miller), ♂ genitalia slide M-1208.

PARATYPES: Mexico: Baja California Sur: La Paz: Guaycura Hotel grounds, Nov. 6, 1961, 1♂. Baja California Sur: Rancho Vinarama, Oct. 23, 1951, 1♂ 1♀. Baja California Sur: Rancho El Novillo, Oct. 28, 1961, 1♂. Baja California Sur: Rancho Palmarito, Oct. 27, 1961, 2♂; Oct. 31, 1961, 1♂ 1♀; Nov. 5, 1961, 1♂. Same locality and date as holotype, 1♂. Baja California Sur: roadway 5 km. south of Rancho Buenavista, Oct. 25, 1951, 1♂ 1♀. Baja California Sur: Boca de la Sierra, Nov. 17, 1951, 1♂; Nov. 18, 1961, 1♂. Baja California Sur: 4 mi. south of Arroyo Candelaria, Oct. 26, 1961, 1♂ 1♀; Nov. 24, 1961, 1♂. All foregoing collected by Cary-Carnegie Expedition. Baja California Sur: 15 mi. south of La Paz, Aug. 31 1959 (K.W. Radford and F.G. Werner), 2♂. Baja California Sur: Candelaro Bay: Espiritu Santo Island, June 30, 1964 (R. Bandar), 3♂ 1♀.

The holotype male, eleven male and three female paratypes are deposited in Carnegie Museum. Three male and one female paratypes are deposited in the California Academy of Sciences. Four male and one female paratypes are deposited in the collection of C. Don MacNeill.

This subspecies is not the one mentioned by MacNeill in a previous paper (1962:98). The specimen he recorded in 1962 was a male from the Sierra de la Victoria, whereas the present subspecies seems to be restricted to the lowlands. It is probable that the population MacNeill cited represents yet another peninsular *C. hippalus* subspecies.

C. h. peninsularis is rather widespread throughout the Cape region in the better watered places. It does not occur in the most arid desert, and even where it is present it is never abundant. This butterfly has about the same habits as typical members of *C. hippalus* in Arizona.



Figs. 1, 2. *Cogia hippalus peninsularis,* new subspecies. Fig. 1, upper surface of holotype ♂, Arroyo San Bartolo, Baja California Sur, Nov. 3, 1961. Fig. 2, upper surface of paratype ♀, Rancho Vinarama, Baja California Sur, Oct. 23, 1961.

Figs. 3-6. *Polites sabuleti margaretae,* new subspecies. Fig. 3, upper surface, and fig. 4, under surface of holotype ♂, S.E. shore of La Paz harbor, Baja California Sur, Dec. 6, 1961. Fig. 5, upper surface, and fig. 6, under surface of paratype ♀, same locality and date.

Polites sabuleti margaretae, new subspecies

Figures 3, 4 (male holotype), 5, 6 (female paratype), 8 (male genitalia)

MALE: Head, thorax, and abdomen dark brown clothed with fulvous and brown scales above and golden-fulvous ones below. Palpi fulvous above and pale ochreous below. Antennae brown, heavily intermixed with fulvous except on the nudum. Legs heavily scaled with golden-fulvous in fresh specimens. Upper surface of wings marked about as in *P. s. sabuleti* (Boisduval), but the fuscous borders are broader, darker, and more clearly defined. Stigma slender, its width about equal throughout its length so that its baso-costal margin is as angular-sigmoid as its anal margin. The fulvous and fuscous areas of the upper surface are darker than in the nominate subspecies, more closely approximating the shades seen in *P. s. tecumseh* (Grinnell), but the fulvous is richer with reddish tones. The under surface is much darker than in any previously described subspecies. The forewings have the fuscous border of the upper surface completely reproduced on the under side with no apical fulvous shading as in other subspecies, and a well defined basal dark area connected to the marginal border along the inner margin. The hindwings below are rich chocolate brown heavily overscaled in fresh specimens with yellow scales, particularly in the area of the anal veins. The other veins are lightly, but distinctly, indicated by yellow scaling, and the yellow discal spots are much reduced, resulting in a narrow, but clearly defined, discal band that is unique in populations of *P. s. sabuleti.* The basal yellow loop on the under surface of the hindwings is obsolescent and represented only by yellow bars on either side of the cell. The male genitalia are identical with those of the nominate subspecies. Length of forewing of the male holotype is 12.0 mm. The 32 male paratypes have forewing lengths between 11.0 and 13.0 mm., averaging 12.1 mm.

FEMALE: Head, body, and appendages as in the male. The upper surface of the wings is similar to that of *P. s. sabuleti,* but of a deeper color, and the fulvous markings are reduced. The contrast between the dark borders and fulvous discal markings is greater in *P. s. margaretae* than in the other nominate subspecies. The under surface is as that described for the male. The forewing lengths of the 23 female paratypes range from 12.5 to 15.0 mm., averaging 13.8 mm.

Described from 56 specimens, 33 males and 23 females, from the southeastern shore of La Paz harbor, Baja California Sur.

HOLOTYPE MALE: Mexico: Baja California Sur: southeastern shore of La Paz harbor, Dec. 6, 1961, Cary-Carnegie Expedition (Lee D. Miller), ♂ genitalia slide M-1206.

PARATYPES: Same locality as holotype, Nov. 8, 1961, 3♂ 1♀; Nov. 10, 1961, 1♂ 7♀; Dec. 5, 1961, 12♂ 5♀; Dec. 6, 1961, 16♂ 10♀. All collected by Cary-Carnegie Expedition.

The holotype male, 25 male and 15 female paratypes are deposited in Carnegie Museum. Four male and four female paratypes are deposited in the California Academy of Sciences. Four male and four female paratypes are deposited in the collection of C. Don MacNeill.

We take great pleasure in naming this beautiful skipper for Mrs. Margaret M. Cary of Philadelphia, Pennsylvania, whose generosity made possible the Cary-Carnegie Expedition and whose work on the

American Sphingidae has so greatly enriched our knowledge of that group.

This is the subspecies of *P. sabuleti,* discussed but not named by MacNeill (1962: 109), from the Cape region. It is by far the darkest and most distinctly marked of any of the subspecies and may be readily distinguished by the slender angled stigma of the males above and by the narrow discal band, pale veins, chocolate-brown ground color, and obsolete basal loop on the under surface of the hindwings.

The population described is from a narrow strip of the coastal grassland just inland from the *Salicornia* flats, but seaward of the more typical desert scrub. This area is intermittently flooded by storms and abnormally high tides, but the usual tides do not reach it. The unidentified grass with which *P. S. margaretae* is associated is apparently moderately tolerant to salt water (there are some salt deposits on the ground where the grass is growing) but cannot survive the daily flooding of the normal intertidal zone; we saw no examples of the grass in the tidal basin proper.

The butterflies seldom stray far from the grass but visit the associated flowers regularly. The flight of these skippers is erratic and close to the ground. This is particularly true of the females, which are most commonly found in the clumps of grass. The males are very alert, frequently darting at and chasing others of their own species.

P. s. margaretae is notably local and was found in no other coastal area sampled by the expedition. It should be sought elsewhere in suitable habitats in the Cape region, however.

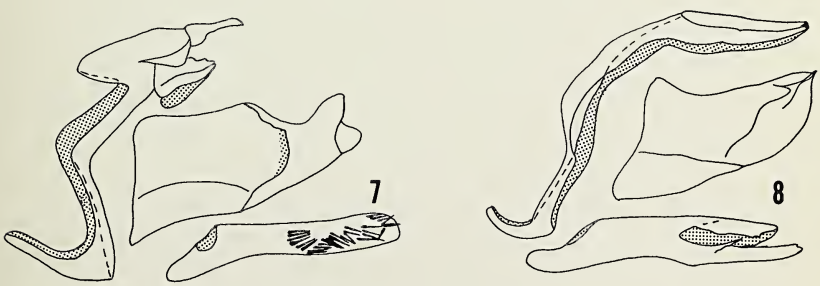


Fig. 7. *Cogia hippalus peninsularis,* new subspecies, ♂ genitalia of holotype.
Fig. 8, *Polites sabuleti margaretae,* new subspecies, ♂ genitalia of holotype.

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Article 3 Annals of Carnegie Museum Volume 41

REPORTS ON THE MARGARET M. CARY-CARNEGIE MUSEUM EXPEDITION TO BAJA CALIFORNIA, MEXICO, 1961

6. The Subfamily Ennominae (Geometridae: Lepidoptera)

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This is the sixth of a series of papers based on the Margaret M. Cary-Carnegie Museum Expedition to Baja California, Mexico, to appear in the Annals of Carnegie Museum. For an account of the itinerary and description of localities, see the first paper in this series [Richard M. Fox, Ann. Carnegie Mus. 36 (16): 181-192].

The Expedition caught a total of 354 specimens representing 45 different species and subspecies that belong to the Ennominae. These were caught on the peninsula and the mainland. All, with one exception, have been placed at least to genus. The one exception is a single, rather worn female from Arroyo San Bartolo, Baja California, November 1, 1961 (genitalic slide F.H.R. No. 12,611). Apparently it belongs in the Cleorini; a male is necessary for accurate placement. This species is not included in the text of this paper.

In the Territory of Baja California Sur 32 species were taken. Of these, five are uncertain as to species. Of the remainder, three are endemic to the peninsula. Two of these three are species of nearctic genera and the third is a new subspecies of a widely ranging neotropical species. The faunal relationships of the Ennominae of Baja California Sur are strongly nearctic, as 22 of the species are northern, whereas only three belong to present-day neotropical species.

Two new species, one a peninsular endemic and the other occurring around the Gulf of California in both Sonora and Baja California, are described in this paper. Two new subspecies of the widely ranging *Thyrinteina arnobia* (Stoll) are also described. One is from western Mexico and the other is an endemic population in the Territory of Baja California Sur.

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A word of caution is necessary regarding some of the generic and specific names used in this paper. A number of the names can be relied on with confidence; these are ones that have been included in modern revisionary studies (Rindge, 1959a, 1959b, 1961, 1966) or are species that occur in the United States. Many of the remaining names should be considered as being tentatively applied, pending revisionary studies of the groups concerned.

Abbreviations of museum names used frequently in this article are: AMNH, the American Museum of Natural History; CM, Carnegie Museum.

Subfamily ENNOMINAE

Ixala klotsi Sperry

Ixala klotsi Sperry, 1940: 146.

A single battered specimen is placed here, based primarily on a study of the genitalia. The species was described from Arizona.

BAJA CALIFORNIA SUR: Bahia de Palmas, Oct. 24, 1961, 1♀ (CM).

Pterospoda kinoi, new species

Figs. 1, 2, 7, 8

An undescribed species of *Pterospoda* occurs around the Gulf of California, and it is apparently seasonally dimorphic. The spring generation is large and has a pinkish brown upper surface, whereas the summer generation is smaller and the males, in particular, have much more ochraceous wings.

MALE, SPRING GENERATION: Head with vertex creamy white, becoming dark gray above front; front brownish gray; palpi brownish gray or grayish brown. Thorax pinkish gray or brownish gray above, with collar tending to be slightly darker; whitish below; legs grayish white, fore and middle legs dark gray on outer surfaces. Abdomen dull pinkish gray above, with scattered brownish gray scales; paler below.

Upper Surface of Wings: Forewings grayish brown, suffused with pink, with veins and subterminal area pinkish; cross lines obsolescent; t. a. and median lines, when present, nebulous and proceeding across wing at right angle to inner margin; discal dot black, small; t. p. line, when present, slightly more sinuous than other lines; s. t. line weakly represented, black, outwardly angulate in cells, shaded outwardly by white, with angulations broadly filled in with pink; terminal line absent, intravenular spots black; fringe concolorous with wing. Hind wings concolorous with forewings; maculation obsolescent except for s. t. line, similar to that of forewing; discal dot absent. (See fig. 1.)

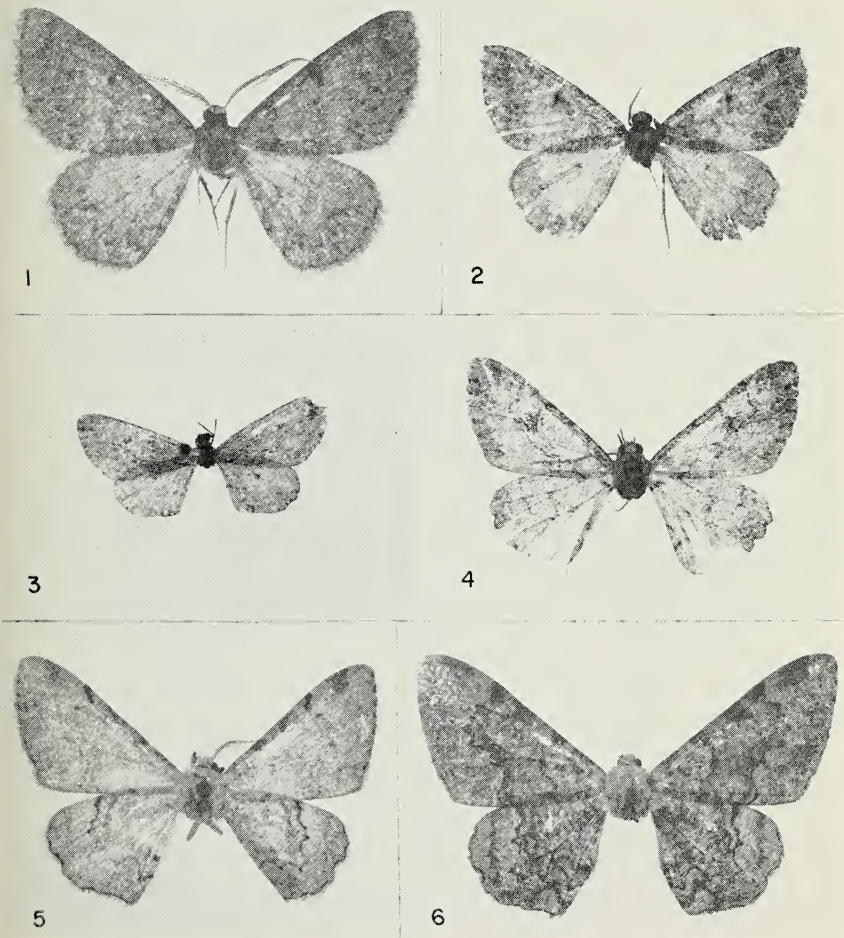
Under Surface of Wings: All wings pale gray, more or less irrorate with dark gray scales; costa of forewing, and some veins, pale brownish gray; without maculation except for discal dot on forewings, and with nebulous, dark gray subterminal band on forewings of some specimens.

Length of Forewing: 18 to 19 mm.; holotype, 18 mm.

FEMALE, SPRING GENERATION: Similar to male, or more suffused with dark gray scaling.

Length of Forewing: 14 to 19 mm.; allotype, 14 mm.

MALE, SUMMER GENERATION: Similar to male of spring generation but smaller, with front and upper surfaces of body and wings ochraceous, overlain with dark



Figs. 1, 2. *Pterospoda kinoi,* new species. 1. Holotype, male. 2. Paratype, male.

Fig. 3. *Morina daedalea,* new species, holotype.

Fig. 4. *Anacamptodes cerasta* Rindge, holotype.

Fig. 5. *Thyrinteina arnobia tephra,* new subspecies, holotype.

Fig. 6. *Thyrinteina arnobia picta,* new subspecies, holotype. All figures x1.5.

gray and grayish brown scales; terminal area of all wings dark gray or grayish brown; faint traces of pink in subterminal area and on veins. Under surface with definite subterminal band on forewings. (See fig. 2.)

Length of Forewing: 14 to 15 mm.

FEMALE, SUMMER GENERATION: Upper surfaces of thorax and abdomen and all wings dark grayish brown above; upper surface without maculation except for discal dot on forewings and for reddish brown subterminal band on all wings, sometimes obsolescent, and for traces of s. t. line. Under surface grayish brown, with outer portion of wings darker.

Length of Forewing: 15 to 16 mm.

MALE GENITALIA: Uncus elongate, curving; gnathos weakly sclerotized, anterior margin broad, flat; valves slender, apically curving, inner face with numerous slender setae; costa of valve with large, sclerotized process at base, extending about one-third of length of costa, roughly triangular in outline, but with apex curved inwardly, and with median ridge extending from apex to base of valve; transtilla represented by inwardly projecting lobes meeting at mid-line; anellus



Figs. 7, 8. Genitalia of *Pterospoda kinoi*, new species. 7. Holotype, male. 8. Allotype, female.

small, elliptical; aedeagus very long and slender, longer than combined lengths of uncus, tegumen, and saccus; vesica armed with row of heavy spines occupying about one-half length of aedeagus.

FEMALE GENITALIA: Sterigma elliptical, bluntly pointed anteriorly and flattened posteriorly, membranous, with small lunate sclerotized piece medially; ductus bursae sclerotized, elongate, weakly constricted medially, anterior end partly rotated; ductus seminalis arising dorsally from near posterior end of corpus bursae; latter large, increasing in width anteriorly, and with ventral swelling, central portion thickly set with numerous inwardly projecting spinose processes.

TYPES: Holotype, male: Mexico: Sonora: Bahia San Carlos: February 18, 1963 (P. H. Arnaud, Jr.), AMNH; allotype, female, same data but February 19, 1963 (AMNH). The genitalia of the holotype are mounted on slide F.H.R. No. 11,590; and of the allotype on F.H.R. No. 11,715. Paratypes, all from Mexico: same data as holotype, February 17, 19, 1963, three males (AMNH); Gulf of California: Isla San Marcos (27°13'N., 112°50'W.), March 28, 1962 (C. F. Harbison), six males and five females (San Diego Natural History Museum); Baja California Sur: Arroyo San Bartolo, November 13, 1961 (Cary-Carnegie Museum Expedition), three males and one female (CM); Baja California Sur: La Paz: Guaycura Hotel grounds, October 20, 1961 (Cary-Carnegie Museum Expedition), one female (CM).

REMARKS: A total of 21 specimens (13 males and eight females) and eight genitalic dissections (four males and four females) have been studied.

There is no doubt that the moths from these three localities belong to a single species, as the genitalia are so similar. The only question is whether the population on the peninsula should be accorded subspecific status or not. Until adequate material is obtained, captured throughout the year, it is thought advisable to place these differently colored moths as seasonal forms of the same species.

Pterospoda kinoi is closely related to *P. opuscularia* (Hulst), and can be distinguished therefrom by its darker color and less definitely defined maculation, as well as by the genitalia. The male structures of the present species can be recognized by the non-spinose costal process, and by the row of numerous spines in the vesica of the aedeagus. The female genitalia of *kinoi* lack the heavily sclerotized ostial ring of *opuscularia*, and have a much longer ductus bursae and a ventral swelling of the corpus bursae not present in *opuscularia*.

This species is named in honor of Father Eusebio Francisco Kino, the great explorer and missionary of Baja California and Sonora.

Syrrhodia decrepitaria Hübner

Syrrhodia decrepitaria Hübner, 1823: 29, figs. 371, 372.

Two specimens were taken in Baja California Sur. This species occurs in much of South America, extending north as far as southern Texas. It is apparently not rare in Mexico.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Dec. 2, 1961, 1♂; Arroyo San Bartolo, Nov. 13, 1961, 1♂. (1♂ CM, 1♂ AMNH).

Thysanopyga carfinia (Druce)

Pachydia carfinia Druce, 1893 (1891-1900): 136; 1893 (1881-1900), pl. 53, figs. 25, 26.

Druce described *carfinia* from specimens taken in Veracruz, Mexico, Guatemala, and Chiriqui, Panama. The species is known to occur in Chiapas and Oaxaca, Mexico, and in British Honduras.

SINALOA: 16 miles north of Mazatlan, Oct. 28, 1961, 1♀ (CM).

Thysanopyga sp.

A study of the types, plus a designation of lectotypes, is necessary in the complex of small species that includes *nicetaria* Guenée, *cermala* Druce, and *oroanda* Druce, before a meaningful usage of names is possible. An examination of the genitalia shows that a number of species are more easily recognized by the genitalia than by maculation; the latter can be quite variable within a species.

SONORA: Navojoa, Oct. 21, 1961, 1♀.

SINALOA: Mazatlan: at motel, Oct. 24, 1961, 1♂; 5 miles west of Concordia, Nov. 2, 1961, 2♂, 5♀; 16 miles north of Mazatlan, Oct. 28, 29, 1961, 6♂, 10♀.

The specimens are in the following collections: 6♂, 12♀ CM; 3♂, 4♀ AMNH.

Chloraspilates bicoloraria Packard

Chloraspilates bicoloraria Packard, 1876:212, pl. 13, fig. 40.

This species ranges from Texas to southern Nevada and southeastern California; in Mexico it is known from Coahuila, Chihuahua, and Sonora. The single specimen from the trip is a small, worn and faded male that has been determined largely on the basis of a study of its genitalia.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct. 26, 1961, 1♂ (CM).

Fernaldella fimitaria angelata Wright

Fernaldella fimitaria angelata Wright, 1923: 114.

Wright's type material of three males and one female came from Angeles Bay, Lower California (holotype and paratype), and from Guaymas, Sonora (allotype and paratype). The second paratype referred to has been examined and dissected, and its genitalia agree with the notes on the holotype genitalia kindly provided me by Dr. C. D. MacNeill. This population is apparently correctly placed as *fimitaria,* and not *partita.*

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct. 20 to Dec. 5, 1961, 5♂, 2♀; Bahia de Palmas, Oct. (without date) 1961, 1♂. (4♂, 1♀ CM; 2♂ 1♀ AMNH).

Semiothisa punctolineata (Packard)

Macaria puncto-lineata Packard, 1873: 64.

Packard described this species from Texas. It extends from that state across the southeastern portion of the United States to Florida. Specimens of this species, taken in Sinaloa, Sonora, and Baja California Sur by members of the expedition, are in the following collections: 7♂, 3♀ CM; 5♂, 5♀ AMNH.

SINALOA: 5 miles west of Concordia, Nov. 2, 1961, 6♂, 2♀; 16 miles north of Mazatlan, Oct. 28, 1961, 3♂; 18 miles north of Mazatlan, Oct. 29, 1961, 1♂, 1♀.

SONORA: Navojoa, Oct. 21, 1961, 2♂; Guaymas, Oct. 20, 1961, 2♀.
BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct 20, 1961, 2♀; Bahia de Palmas, Nov. 16, 1961, 1♀.

Semiothisa errata McDunnough

Semiothisa errata McDunnough, 1939: 252.

Two specimens of this moth, described from Arizona, were taken.
BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct. 20, Dec. 2, 1961, 1♂, 1♀. (1♂ CM; 1♀ AMNH).

Semiothisa parcata (Grossbeck)

Sciagraphia parcata Grossbeck, 1908: 26.

This species is common in Arizona. It also occurs in Nevada, Sonora, and Baja California Norte.

SONORA: Sonoyta, Oct. 17, 18, 1961, 3♂, 3♀; Guaymas, Oct. 20, 1961, 1♀.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct. 20, 1961, 1♀.

The specimens are in the following collections: 2♂, 3♀ CM; 1♂, 2♀ AMNH.

Semiothisa colorata Grote

Semiothisa colorata Grote, 1883: 7.

S. colorata is one of the commoner species in the semi-arid portion of the southwestern United States, as it extends from southern California to western Texas. It is also known from Sonora and Baja California Norte.

SONORA: Sonoyta, Oct. 17, 18, 1961, 2♂, 7♀.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct. 20, Nov. 6, 1961, 2♀.

The specimens are in the following collections: 1♂, 5♀ CM; 1♂, 4♀ AMNH.

Semiothisa sp., ?*sublacteolata* (Hulst)

Sciagraphia sublacteolata Hulst, 1887: 189.

Hulst described this species from Dayton, Ohio; the few specimens that have been available for study were taken in Texas. The single specimen taken on the expedition is smaller and darker than the single Texas female before the author. The genitalia of these two moths are very similar. Pending receipt of adequate material, the specimen is tentatively referred to this species.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct. 31, 1961, 1♀. (CM).

Semiothisa pictipennata (Hulst)

Macaria pictipennata Hulst, 1898: 162.

This species occurs from western Texas to California, and it is known from Baja California Norte.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct. 20 to Dec. 5, 1961, 7♂, 4♀. (3♂, 2♀ CM; 4♂, 2♀ AMNH).

Semiothisa nigricomma Warren

Semiothisa nigricomma Warren, 1904: 127.

Warren described this species from Guadalajara, Jalisco. It extends north into southern Texas.

SINALOA: 16 miles north of Mazatlan, Oct. 28, 1961, 2♀; 18 miles north of Mazatlan, Oct. 29, 1961, 4♂,3♀. (2♂, 3♀ CM; 2♂, 2♀ AMNH).

Semiothisa sp.

Six specimens were taken of a species that is allied to *nigricomma;* this moth is also known from southern Arizona.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Nov. 2, 5, 1961, 1♂, 2♀; Arroyo San Bartolo, Nov. 13, 1961, 1♂, 2♀. (1♂, 2♀ CM; 1♂, 2♀ AMNH).

Semiothisa sirenata McDunnough

Semiothisa sirenata McDunnough, 1939: 254.

This species was described from Arizona; it also occurs in southern California, southern Nevada, and Sonora.

SONORA: Navojoa, Oct, 21, 1961, 3♂; Sonoyta, Oct. 17, 1961, 2♀.

BAJA CALIFORNIA SUR: Bahia de Palmas, Oct. 24, 1961, 1♂; La Paz: Guaycura Hotel grounds, Oct. 20, Nov. 6, 1961, 2♀.

The specimens are in the following collections: 3♂, 2♀ CM; 1♂, 2♀ AMNH.

Semiothisa cyda (Druce)

Eubolia cyda Druce, 1892 (1891-1900): 177; 1893 (1881-1900), pl. 58, fig. 4 (lectotype).

Semiothisa cyda: Rindge, 1959b: 8, figs. 2, 6, 10 (male and female genitalia).

This species is very common and widely ranging throughout the southwestern United States and much of Mexico. See Rindge (1959b) for a complete list of the states involved.

SONORA: Sonoyta, Oct. 17, 18, 1961, 6♂, 14♀.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct. 20 to Dec. 6, 1961, 25♂, 28♀.

The specimens are in the following collections: 15♂, 21♀ CM; 16♂, 21♀ AMNH.

Semiothisa melanderi Sperry

Phasiane s-signata form *ballandrata* Wright, 1923: 115.

Semiothisa melanderi Sperry, 1948: 58. Rindge, 1959b: 13, figs. 4, 8, 11 (male and female genitalia).

This species looks almost exactly like *S. cyda*. Specimens of the two were captured together at La Paz. Good differences are present in the ventral plate of the male, as well as in the genitalia of both species. It has been known heretofore from Arizona and Baja California Norte.

Wright's older "form" name is not used, following Article 45 of the International Code of Nomenclature.

SONORA: Navojoa, Oct. 21, 1961, 1♂, 3♀; Guaymas, Oct. 20, 1961, 1♀. 4♂, 12♀.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct. 19 to Dec. 6, 1961, 4♂, 12♀.

The specimens are in the following collections: 2♂, 10♀ CM; 3♂ 6♀ AMNH.

Semiothisa hypaethrata (Grote)

Phasiane hypaethrata Grote, 1881: 167.

This species is known from southern Arizona and southwestern New Mexico.

SONORA: Sonoyta, Oct. 17, 1961, 2♀; Guaymas, Oct. 20, 1961, 1♂.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct. 19 to Nov. 6, 1961, 3♂, 4♀; Bahia de Palmas, Oct. 24, 1961, 1♀.

The specimens are in the following collections: 3♂, 3♀ CM; 1♂, 4♀ AMNH.

Semiothisa sp.

Three worn females represent a species unknown to me; they have the seventh sternite sclerotized.

BAJA CALIFORNIA SUR: San Jose del Cabo, Nov. 17, 1961, 2♀; Bahia de Palmas, Nov. 16, 1961, 1♀. (2♀ CM; 1♀ AMNH.)

Prophasiane sp.

A single female was taken that is related to *mendicata* Hulst.

BAJA CALIFORNIA SUR: Bahia de Palmas, Nov. 17, 1961. 1♀ (CM).

Itame sobriaria Barnes and McDunnough, new status

Itame graphidaria sobriaria Barnes and McDunnough, 1917: 239, pl. 24, fig. 9.

This name was proposed as an Arizona subspecies of the Texan *graphidaria* Hulst. The two are similar in appearance but the genitalia of both sexes are quite distinct. This species is also known from New Mexico and Chihuahua.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct. 20 to Nov. 10, 1961, 3♂, 4♀. (2♂, 2♀ CM; 1♂, 2♀ AMNH).

Glaucina eupetheciaria osiana (Druce)

Eupithecia (?) *osiana* Druce, 1893 (1891-1900): 147; 1893 (1881-1900), pl. 55, figs. 5, 6.

Glaucina eupetheciaria osiana: Rindge, 1959a: 294, pl. 24, figs. 8, 9; text fig. 24.

A number of specimens of both sexes were taken in the Central Gulf Coast area, and these are tentatively assigned to the Sonoran subspecies of *eupetheciaria.* Unfortunately most of the specimens were rubbed, so that an accurate comparison with Sonoran examples is not feasible. The Baja California examples seem to be paler than *osiana* but more material is needed before this can be ascertained for certain.

SONORA: Navojoa, Oct. 21, 1♂.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct. 20, 31, Nov. 5, 8, Dec. 6, 1961, 5♂, 4♀; Bahia de Palmas, Oct. 24, Nov. 16, 1961, 8♀; San Jose del Cabo, Nov. 17, 1961, 1♀.

The specimens are in the following collections: 4♂, 6♀ CM; 2♂, 7♀ AMNH.

Glaucina anomala Rindge

Glaucina anomala Rindge, 1959a: 341, pl. 27, figs. 10, 11; text figs. 31, 70, 103.

Four specimens of this anomalous species were taken in the Central Gulf Coast area near the sea. It has been previously known from southeastern Arizona and the lower portions of the Sierra Madre Occidental of southern Sonora.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct. 20, 23, 1961, 1♂, 1♀; Bahia de Palmas, Nov. 12, 16, 1961, 2♂. (1♂, 1♀ CM; 2♂ AMNH).

Synglochis perumbraria Hulst

Synglochis perumbraria Hulst, 1896: 352. Rindge, 1959a: 343, pl. 27, figs. 12, 13; text figs. 33-35, 71, 104.

This species occurs throughout the southwestern United States; in Mexico it is known to occur in Coahuila and Baja California Norte. The five specimens taken are the first ones examined from Sonora.

SONORA: Sonoyta, Oct. 17, 18, 1961, 2♂, 2♀; 10 miles east of San Luis, Oct. 17, 1961, 1♀. (1♂, 2♀ CM; 1♂, 1♀ AMNH).

Eubarnesia ritaria ritaria (Grossbeck)

Cedaria ritaria Grossbeck, 1910: 207.

Eubarnesia ritaria ritaria: Rindge, 1959a: 346, pl. 27, figs. 14, 15; text figs. 36, 72, 105.

One specimen was taken near the Arizona border in Sonora. Nominate *ritaria* is found in Arizona and western Texas.

SONORA: Sonoyta, Oct. 17, 1961, 1♂ (CM).

Eubarnesia ritaria arida Rindge

Eubarnesia ritaria arida Rindge, 1959a: 347, pl. 27, figs. 16, 17; text fig. 36.

This paler subspecies is known to occur in southern California, northern Sonora, and Baja California Norte. The present records extend its distribution much farther south on the peninsula.

BAJA CALIFORNIA SUR: Bahia de Palmas, Oct. 24, Nov. 16, 1961, 3♂; La Paz: Guaycura Hotel grounds, Oct. 26, Nov. 1, 6, 8, 1961, 2♂, 3♀. (3♂, 1♀ CM; 2♂, 2♀ AMNH).

Morina daedalea, new species
Figs. 3, 9, 10

This species can be recognized by the presence of prominent discal spots on all wings above, and by the genitalia of both sexes. It is endemic to Baja California Sur.

MALE: Head with vertex white or ochraceous white; front ochraceous around large truncate tubercle; palpi ochraceous. Thorax ochraceous white above, paler below; legs ochraceous brown, with all tarsi darker. Abdomen ochraceous above, with white and ochraceous brown scales; paler below.

Upper Surface of Wings: Forewings grayish white, with ochraceous and brown scaling; cross lines dark brown, narrow; t. a. line crossing costa at right angle, then swinging basad and paralleling costa to inner margin; discal spot large, dark brown, circular; t. p. line extending from about vein R_5 and proceeding, with two basal bends, to inner margin just basad of its middle; large patch of ochraceous brown scales distad of t. p. line above inner margin, and continuing anteriorly as shade band; subterminal and terminal areas with some brown scaling in cells; dark intravenular dots present along wing margin; fringe concolorous with wing. Hind wings white, with scattered brown scales, particularly along outer and anal margins; discal dot dark grayish brown, prominent; traces of intradiscal, extradiscal and subterminal lines present at anal margin and extending part way across wing; terminal line dark, narrow, obsolescent.

Under Surface of Wings: Grayish white, with variable number of dark brown and ochraceous scales; without maculation except for large, brownish black discal dots, and narrow, dark terminal line.

Length of Forewing: 10 to 12 mm.; holotype, 10.5 mm.

FEMALE: Similar to male, as far as can be seen.

Length of Forewing: 10 mm. (allotype).

MALE GENITALIA: Uncus elongate, triangular, with sides weakly concave; gnathos with large median enlargement bluntly pointed or rounded; valves with sacculus broad, lightly sclerotized, and with raised ridge having from six to 12 heavy short, well-spaced spines; anellus with large, sclerotized, rounded anterior part, becoming narrowed medially and with posterior margin rounded; aedeagus longer than combined lengths of uncus, tegumen, and saccus, posterior end bifid, with narrow, heavily sclerotized tine-like process and wider, hollow, less heavily sclerotized projection, and with anterior end broadly swollen; vesica unarmed.



Figs. 9, 10. Genitalia of *Morina daedalea*, new species. 9. Holotype, male. 10. Allotype, female.

FEMALE GENITALIA: Sterigmal area broad, sclerotized, anterior margin bilobate; ductus bursae short, broad, curved, and with large swelling on left side; ductus seminalis arising from posterior end of corpus bursae on right side; corpus bursae globular, membranous, with large dorsal signum having transverse ridge.

TYPES: Holotype, male, and allotype, female, Guaycura Hotel grounds, La Paz, Baja California Sur, Mexico, October 31, 1961, Cary-Carnegie Museum Expedition (CM). The genitalia of the holotype are on slide F.H.R. No. 12,601, and of the allotype on F.H.R. No. 14,580. Paratypes: same data as types, November 5 and December 1, 1961, two males (CM; AMNH).

REMARKS: The male genitalia of *daedalea* can be separated from those of *M. coniferarum* Grossbeck by the much sparser spining on the sacculus and by the bifurcate apex of the aedeagus. In the female genitalia, the present species can be recognized by the wider sclerotized sterigma and by the thicker, curved, and swollen ductus bursae.

The description of the adults may have to be somewhat modified when additional material comes to hand.

Anavitrinella pampinaria (Guenée)

Boarmia pampinaria Guenée, 1857: 245.

This species occurs from coast to coast in the United States, and south into Mexico.

SONORA: Navojoa, Oct. 21, 1961, 1♂ (CM).

Anavitrinella sp.

This species is yellowish brown, and has a curved t. p. line; it is placed in *Anavitrinella* on the basis of the genitalic structures. No name is being given to it at this time, pending a revisionary study of this genus.

BAJA CALIFORNIA SUR: Arroyo San Bartolo, Nov. 1, 13, 1961, 1♂, 2♀; La Paz: Guaycura Hotel grounds, Nov. 6, 8, 1961, 2♀; Bahia de Palmas, Nov. 17, 1961, 1♀. (4♀ CM; 1♂, 1♀ AMNH.)

Anacamptodes pseudoherse Rindge

Anacamptodes pseudoherse Rindge, 1966: 218, pl. 24, fig. 8; text figs. 27, 47.

The two specimens that were taken have been made paratypes. This species is widely distributed over much of Mexico.

SINALOA: Los Mochis, Oct. 22, 1961, 1♀ (CM).

BAJA CALIFORNIA SUR: Arroyo San Bartolo, Nov. 13, 1961, 1♂ (CM).

Anacamptodes cerasta Rindge
Fig. 4

Anacamptodes cerasta Rindge, 1966: 221, pl. 24, fig. 11; text figs. 28, 48.

This species is endemic in the Territory of Baja California, and has been captured only at La Paz.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct. 20, 23, 31, Nov. 5, 8, Dec. 1, 6, 1961, 7♂, 4♀. (4♂, 2♀ CM; 3♂, 2♀ AMNH).

Thyrinteina arnobia picta, new subspecies
Fig. 6

Thyrinteina arnobia phala Rindge, 1961: 135 *(partim).* Comstock and Vazquez, "1963" [1964]: 263, fig. 18.

In this population, found in western Mexico and Guatemala, the wings of the males are predominately brown.

MALE: Head, thorax and abdomen similar to those of nominate subspecies, but with last two tending to have more dark scaling.

Upper Surface of Wings: Forewings, ground color gray, heavily and evenly overlain with brown and dark brown scales, the latter tending to be concentrated in median area. Hind wings concolorous with forewings, or with ground color more prominent in subterminal and terminal areas; maculation of all wings like that of nominate subspecies.

Under Surface of Wings: All wings unicolorous dark brown or dark grayish brown; either without maculation or with t. p. and extradiscal lines weakly represented.

Length of Forewing: 16 to 19 mm.; holotype, 19 mm.

FEMALE: Similar to that of *phala* but tending to be slightly more suffused with dark scales, and with s. t. line slightly stronger.

Length of Forewing: 27 mm. (allotype).

MALE GENITALIA: Similar to those of *phala.*

FEMALE GENITALIA: Not examined.

TYPES: Holotype, male, Agua del Obispo, Guerrero, Mexico, July, 1932 (C. C. Hoffmann; paratype of *phala* Rindge) (AMNH); allotype, female, Puerto Vallarta, Jalisco, Mexico, emerged from pupa September 15, 1957 (J. A. Comstock) (AMNH). The genitalia of the holotype are on slide F.H.R. No. 8987. Paratypes, all from Mexico: same data as holotype, one male (AMNH); "La Granja," Chiapas, July, 1930 (C. C. Hoffmann; paratype of *phala* Rindge), one male (AMNH); 5 miles west of Concordia, Sinaloa, November 2, 1961 (Cary-Carnegie Museum Expedition), two males (AMNH, CM); 16 miles north of Mazatlan, Sinaloa, October 28, 1961 (Cary-Carnegie Museum Expedition), one male, CM. (4♂, 1♀ AMNH; 2♂ CM).

REMARKS: Seven specimens and one genitalic dissection were examined. Typical *phala* is characterized by the white upper surface of the wings in the male (Rindge, 1961, pl. 22, fig. 2). It occurs from southern Texas through eastern Mexico and at least as far south as British Honduras. In Mexico it is known from the states of San Luis Potosi, Veracruz, Tabasco, and Yucatan, and from Alta Verapaz in Guatemala. Included in the type series were four dark-brown specimens from Guerrero and Chiapas. With the receipt of additional material from western Mexico it becomes apparent that these brown specimens form a distinct population in that part of the country.

Thyrinteina arnobia tephra, new subspecies
Fig. 5

In Baja California Sur there occurs a population in which the upper surface of the wings of the males is pale gray, overlain with dark scales, and is thus quite distinct from the other two known populations from Mexico.

MALE: Head, thorax, and abdomen similar to those of nominate subspecies, but with abdomen tending to have more dark scales.

Upper Surface of Wings: Forewings with ground color pale gray, lightly overlain with grayish brown and dark-brown scales. Hind wings concolorous with, or slightly paler than, forewings; maculation of all wings like that of nominate subspecies.

Under Surface of Wings: All wings varying in color from gray to dark-grayish brown, and overlain with grayish-brown scales; maculation varying from having t. p. and extradiscal lines present to being obsolescent.

Length of Forewing: 15 to 20 mm.; holotype, 16 mm.

FEMALE: Similar to female of *phala*.

Length of Forewing: 26 to 32 mm.; allotype, 28 mm.

MALE GENITALIA: Similar to those of *phala* but with projections of juxta slightly longer and more slender.

FEMALE GENITALIA: Not examined.

TYPES: Holotype, male, Arroyo San Bartolo, Baja California Sur, Mexico, November 15, 1961 (CM); allotype, female, same data, November 1, 1961 (CM). The genitalia of the holotype are on slide F.H.R. No. 12,573. Paratypes, all from Baja California Sur: same data as holotype, various dates between November 1 and 15, 1961, eight males (CM; AMNH); Guaycura Hotel grounds, La Paz, various dates between October 20 and December 2, 1961, 11 males (CM; AMNH); Bahia de Palmas, various dates between October 24 and November 17, 1961, five males and two females (CM; AMNH); San Jose del Cabo, November 17, 1961, one male (CM); Puerto Chileno, November 25, 1961, one female (CM). All of the above specimens were taken on the Cary-Carnegie Museum expedition. (13♂, 1♀ CM; 12♂, 2♀ AMNH.)

REMARKS: Thirty specimens and two genitalic dissections have been studied. This population is quite distinct from any of the described ones, and can be recognized by the light-gray coloration of the upper surface of the wings of the males.

Stergamataea delicata dolliata Grossbeck

Stergamataea dolliata Grossbeck, 1908: 30.

This population was described from Arizona; it also occurs in western Texas. The single specimen taken by the members of the expedition tends to be slightly darker and more mottled than are most Arizona males. More material is needed before we can ascertain whether or not these differences are constant.

BAJA CALIFORNIA SUR: Arroyo San Bartolo, Nov. 15, 1961, 1♂ (CM).

Nematocampa sp., *?reticulata* Butler

Nematocampa reticulata Butler, 1881: 323.

Butler described *reticulata* from the Amazons of Brazil, and Druce [1892 (1891-1900): 43] gave Mexican records in the states of Sinaloa, Veracruz, and Tabasco. A careful genitalic study and revision of the group is necessary before names can be safely applied in this genus.

SINALOA: 5 miles west of Concordia, Nov. 2, 1961, 1♂ (CM).

Stenaspilates meskearia albomacularia (Hy. Edwards)

Azelina albomacularia Hy. Edwards, 1882: 130.

The four specimens that were taken are smaller in size (length of forewing for the males, 12-13 mm., for the females, 12 mm.) than are most of the examples from Arizona and southern California. However, some of the individuals from the latter state are as small. The range of color variation of the upper surface of the wings in *albomacularia* is rather extensive, and the La Paz specimens are well within this range.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Oct. 20, 26, Nov. 8, Dec. 5, 1961, 2♂, 2♀. (1♂, 1♀ CM; 1♂, 1♀ AMNH).

Pero lignata (Warren)

Pergama lignata Warren, 1897: 499.

Specimens bearing this name are from South America, Costa Rica, Guatemala, and southern Mexico.

SINALOA: 5 miles west of Concordia, Nov. 2, 1961, 1♂; 16 miles north of Mazatlan, Oct. 28, 1961, 1♀; 18 miles north of Mazatlan, Oct. 29, 1961, 1♀. (1♂, 1♀ CM; 1♀ AMNH).

Pero melissa (Druce)

Azelina melissa Druce, 1892 (1891-1900): 63; 1892 (1881-1900), pl. 47, fig. 12.

Druce described this species from Jalapa, Veracruz, Mexico.

BAJA CALIFORNIA SUR: Arroyo San Bartolo, Nov. 13, 15, 1961, 2♀. (1♀ CM; 1♀ AMNH).

Philtraea elegantaria (Hy. Edwards)

Zerene elegantaria Hy. Edwards, 1881: 121.

This species was described from Arizona.

BAJA CALIFORNIA SUR: La Paz: Guaycura Hotel grounds, Dec. 2, 1961, 1♂; Bahia de Palmas, Nov. 17, 1961, 1♀; Puerto Chileno, Nov. 24, 1961, 1♀; San Jose del Cabo, Nov. 17, 1961, 1♀; Arroyo San Bartolo, Nov. 13, 1961, 2♀; Sierra Laguna: Rancho San Bernardo, Nov. 13, 1961, 2♀. (1♂, 4♀ CM; 3♀ AMNH.)

Apicia melenda Druce

Apicia melenda Druce, 1892 (1891-1900): 39; 1892 (1881-1900), pl. 44, figs. 23, 24.

Druce described *melenda* from southern Mexico (Jalisco, Guerrero, Tabasco, and Veracruz), Guatemala, and Panama.

SINALOA: 5 miles west of Concordia, Nov. 2, 1961, 1♂ (CM).

Apicia vibicaria (Cramer)

Phal. Geomet. vibicaria Cramer, 1775: 112, pl. 71D.

This species is of wide occurrence in South and Central America, going as far north as southern Mexico.

SINALOA: 16 miles north of Mazatlan, Oct. 28, 1961, 1♀ (CM).

Halesa meticulata (Guenée)

Drepanodes meticulata Guenée, 1857: 68.

This widely ranging species occurs from Brazil and Peru, through northern South America and Central America, into Mexico. In the last country, specimens have been examined from the states of Chiapas, Oaxaca, Hidalgo, and Veracruz.

SINALOA: 5 miles west of Concordia, Nov. 2, 1961, 4♂; 16 miles north of Mazatlan, Oct. 28, 1961, 1♂.

SONORA: Navojoa, Oct. 21, 1961, 1♂.

The specimens are in the following collections: 4♂ CM; 2♂ AMNH.

Drepanodes epionata Guenée

Drepanodes epionata Guenée, 1857: 68.

Guenée described this species from Haiti, and it is known from the other islands of the Greater Antilles. Specimens are also placed under this name from Central and northern South America; and it is known from southern Texas.

SINALOA: 18 miles north of Mazatlan, Oct. 29, 1961, 1♂ (CM).

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A SYSTEMATIC REVIEW OF *AMEIVA AUBERI* COCTEAU (REPTILIA, TEIIDAE) IN CUBA AND THE BAHAMAS

I. *The Cuban Subspecies* BY ALBERT SCHWARTZ

II. *The Bahamian Subspecies* BY CLARENCE J. MCCOY

III. *Discussion* BY ALBERT SCHWARTZ

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A SYSTEMATIC REVIEW OF *AMEIVA AUBERI* COCTEAU (REPTILIA, TEIIDAE) IN CUBA AND THE BAHAMAS

I. THE CUBAN SUBSPECIES

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The ground lizard *Ameiva auberi* Cocteau, of Cuba and the Isla de Pinos, was described in 1838 or 1839 (Smith and Grant, 1958)[2] in Rámon de la Sagra's monumental "Historia física, política y natural de la Isla de Cuba." Until Hecht (1954) considered the Bahamian *Ameiva thoracica* Cope as conspecific with the Cuban species, the latter was regarded as monotypic. The last revisers of the genus *Ameiva* (Barbour and Noble, 1915) had little material of *A. auberi* (only fifteen specimens from widely scattered localitites on both Cuba and the Isla de Pinos, in no case more than five specimens from any single locality) so that it is not surprising that intraisland variation in *A. auberi* went unnoted. In fact, other than the recent collections made by myself and parties between 1957 and 1960, there is remarkably little material of *A. auberi* in American museums. It is the purpose of the present paper to discuss the variation in *A. auberi* and to comment on the history and affinities of the species.

I have had available for study 668 *Ameiva auberi* specimens collected by myself and assistants in Cuba and the Isla de Pinos under the sponsorship of National Science Foundation grants G-3865 and G-6252. These specimens have all been deposited in the American Museum of Natural History (AMNH). I have also studied lizards in the Carnegie Museum (CM); the Museum of Natural History, University of Kansas (KU); the Museum of Comparative Zoology, (MCZ); the Muséum National d'Historie Naturelle (MNHN); the University of Florida/Florida State Museum (UF); the University of Illinois Museum of Natural History (UIMNH); the Museum of Zoology, University

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2. Bibliography follows section III.

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of Michigan (UMMZ); and the United States National Museum (USNM). For the loans of these lizards I wish to thank Charles M. Bogert and George W. Foley, Neil D. Richmond and Clarence J. McCoy, Jr., William E. Duellman, Ernest E. Williams, Jean Guibé, Walter Auffenberg and Lewis D. Ober, Hobart M. Smith, the late Norman E. Hartweg, Charles F. Walker and Dale Hoyt, the late Doris M. Cochran and James A. Peters. The large quantity of fresh material available to me has been invaluable. These new and carefully documented specimens have accumulated through the efforts of several capable and interested field companions, namely: Edwin B. Erickson, John R. Feick, William H. Gehrmann, Jr., Robert S. Howard, Ronald F. Klinikowski, David C. Leber, Dennis R. Paulson, Peter F. Pepe, Donald R. Price, Frank C. Sentz, Jr., James D. Smallwood, Barton L. Smith, Willard M. Stitzell, James R. Talada, Richard Thomas, and George R. Zug. Of these men, Messrs. Klinikowski and Leber were recipients of National Science Foundation Undergraduate Research Participation grants in 1959 and 1960. I wish especially to acknowledge the help of Armando García and Porfirio Azcuy in western Cuba. Specimens of *A. auberi* from eastern Cuba collected by Major Chapman Grant and in the UIMNH were under study by Dr. Hobart M. Smith. He relinquished his interest in these lizards, and for this courtesy I am very grateful.

In addition to examining specimens in American collections, I have been able, through the courtesy and cooperation of Héctor Sagué D. and Orlando H. Garrido, to examine the excellent collections of *A. auberi* made throughout Cuba by Sr. Garrido for the Instituto de Biología, Academia de Ciencias de Cuba (IB). Also, Sr. Garrido made available to me his notes on color and pattern, as well as color slides of many of the specimens he had collected, and they have proved invaluable. Through the kindness of Mario S. Buide I have been able to study a fine series of *Ameiva* from southern Las Villas Province. Some of these specimens are in Sr. Buide's collection (MSB) and the remainder are in the Albert Schwartz Field Series (ASFS) and in the National Musuem of Canada (NMC). Some lizards, originally in the IB collection, have also been deposited in the ASFS, the CM, and the NMC. A total of 1067 specimens of *Ameiva auberi* is available to me.

Scale counts were taken by William H. Gehrmann, Jr. on several lots of material collected in 1957 and 1958. Indeed the present paper at its inception was to be a joint effort between Mr. Gehrmann and myself, but other duties prevented him from continuing with the study. I am

grateful for his early assistance in compiling data and for allowing me to use his counts.

Ameiva auberi is widespread on Cuba and the Isla de Pinos. The lizard occurs also on many of the offshore keys, including the Laberinto de las Doce Leguas off the south coast of Camagüey Province and the Archipiélago de los Canarreos off Punta del Este of the Isla de Pinos. *A. auberi* is not purely coastal in distribution, occurring in the interior of all Cuban provinces and throughout the the Isla de Pinos. It does not occupy areas that are either extremely mesic or moderately to extremely high. Substrates are usually sandy or rocky (*diente de perro* limestone for example), but gravelly soils (like the Malpais gravel on the Isla de Pinos or the gravelly serpentine savannas of Camagüey Province) are occupied in some regions. In the areas near Soledad, Las Villas Province, and near San Miguel de los Baños in Matanzas Province, *A. auberi* occurs in old abandoned earthen fields that have none of the characters specified above.

Nowhere is *A. auberi* known to occur in the mountains except in the Sierra de los Organos-Sierra del Rosario massif in Pinar del Río Province, unless the occurrence of the species near Palma Soriano in Oriente Province is interpreted as being within the Sierra Maestra (if so interpreted, the elevation is low — about 1000 feet — and hardly to be construed as within the high uplands of this range), and at La Poa in the Cuchillas de Toa. In the Sierra de los Organos, the lizards occur in cultivated areas and in rather arid upland (1000 feet and slightly higher) woods on well-drained and gravelly soils. In this region, *A. auberi* is not associated with the luxuriant forests on the *mogote* sides and summits, but rather with valley floors and drier woods.

Certainly the habitats occupied by the largest number of *A. auberi* are coastal, including offshore cays and islands. In such areas, the lizards occur in beach growth of seagrape and coconuts, in coastal scrub, and xeric coastal woodlands. On some of the cays *A. auberi* occurs on open and hard-packed sandy soils which, in the heat of midsummer, become uncomfortably hot for the collector at midday.

Inspection of the map (Fig. 1) shows that although *A. auberi* occurs virtually from one end of Cuba to the other, there are large areas where these lizards have not been collected. Much of the area whence *A. auberi* is unknown is forested uplands, but some of it is also apparently suitable for occupation by these lizards. The hiatuses may well be the result of lack of collecting in some instances, but in others the lizards simply appear to be absent. For instance, despite several weeks collect-

ing over the years in southern and central Camagüey Province, no *Ameiva auberi* were secured in apparently suitable situations there. Visits to the head of the Bahía de Cochinos in Las Villas Province revealed no lizards in an area of open beach and dry lowland woods — habitats which in southern Oriente would have been aswarm with *Ameiva*. Such incidents, the list of which might be much expanded, indicate that the apparently spotty distribution of *A. auberi* may well be more real than a glance at the map reveals.

I have collected or studied as-yet-unpreserved specimens of all subspecies except three, and have extensive notes on coloration and pattern in life. Such information is absolutely esssential when studying lizards whose coloration is fugitive in preservative and whose pattern may be obliterated by prolonged periods in formalin or alcohol. Borrowed material in most cases has served merely to confirm the existence of these lizards in the general regions where I have taken them, and to confirm as well the differences between subspecies in life. The excellent recent collections in the Instituto de Biología, Academia de Ciencias, La Habana, made by Sr. Garrido, have revealed the presence of *Ameiva* in three other areas. In only one instance (a single example from the Sierra de Jatibonico, Las Villas Province) have I examined an old specimen from an area which is not represented in fresh collections, and of course the treatment of this one individual has been extremely tentative. The racial status of *A. auberi* from two other areas (extreme northeastern Pinar del Río Province; north coast of Camagüey Province north of the Sierra de Cubitas), despite fresh material from both areas, has been left in abeyance. These cases will be discussed in the text.

Nomenclatorial History

Smith and Grant (1958) discussed the authorship of the names pro- work was published in both Spanish and French editions. The Spanish posed by Cocteau and Bibron in de la Sagra's "Historia . . . de Cuba." The edition, which was the earlier published, in twelve folio volumes, contains the description of *Ameiva auberi* in volume 4. Volume 4 of both Spanish and French editions was also published in two parts. From the evidence presented by Smith and Grant, part I of volume 4 of the Spanish edition antedates its homologue in the French edition, the former appearing in 1838 or 1839, and the latter by 1841. As far as authorship is concerned, Smith and Grant (p. 216) stated that Cocteau was the sole author of all material before page 120 of part I of volume 4 of both editions, and that all names after page 120 are to be attributed jointly to

Cocteau and Bibron. Since the original description of *Ameiva auberi* is on page 51 of the (earlier) Spanish edition, the name is presumably to be attributed solely to Cocteau. Additional evidence that *A. auberi* was described only by Cocteau is that the name is followed, at its original place of proposal, by the name of Cocteau only, whereas later names (i.e., *Epicrates angulifer* and *Dromicus angulifer)* are followed by "nobis," thereby suggesting joint authorship. Although the evidence is not completely incontrovertible, it seems appropriate to consider that Cocteau was the author of *Ameiva auberi.*

One other name has been proposed for Cuban *Ameiva: Ameiva trilineata* Gray, 1845. This name was based upon four syntypes in the British Museum (Natural History) collected by W. S. Macleay. Pertinent color data included in the original description are that the species is "olive, with three pale streaks," and that the tail has a "white streak on each side." Gray, although also listing *Ameiva auberi* Cocteau, had obviously not examined material of the latter form and was surely unaware that his *A. trilineata* demonstrated a pattern that is commonplace in juveniles and subadults of several populations of *A. auberi,* and that also persists into the adults of some races. Macleay (*fide* Conde, 1958b:261) lived in Cuba from 1827 to 1836, residing at Guanabacoa to the east of La Habana in Habana Province. Presumably the syntypes of *A. trilineata* were secured in the region near Guanabacoa. In this region at least juvenile and subadult lizards have a trilineate pattern. Consequently I regard *Ameiva trilineata* Gray a strict synonym of *Ameiva auberi* Cocteau.

The monotypic status of *Amiva auberi* was maintained until Hecht (1954:133), in discussing the Bahamian fauna, used the combination *Ameiva auberi thoracica* Cope for the ground lizards of these islands. The similarities between *A. auberi* and *A. thoracica* are obvious upon casual inspection; in fact, Sutcliffe (1952:5) identified as *A. thoracica* a ground lizard from Cayo Largo, of the Archipiélago de los Canarreos off the eastern tip of the Isla de Pinos. This identification was made on the basis of agreement in lepidosis and coloration of the Cayo Largo specimen with Barbour and Noble's diagnosis of *A. thoracica,* in contrast to their diagnosis of *A. auberi.* Although I have not examined this particular individual, a series of these lizards from Cayo Largo shows that they indeed represent a distinctive subspecies of *A. auberi.* The point here, however, is that *auberi* and *thoracica* are very close in both pattern and scalation details, and I have no doubt that they are correctly considered as conspecific. In the present paper I have made no effort to com-

pare the Cuban and Bahamian subspecies of *A. auberi* since the Bahamian lizards are under study by Clarence J. McCoy (see part II of this article). I have examined fairly extensive material from various Bahamian islands and am aware of the variation in both pattern and scalation of these lizards in the Bahamas.

Cocteau (1838 or 1839:54) discussed the coloration of the material before him at the time of the description of *A. auberi*. It is obvious that he had more than a single specimen since he contrasted the juvenile with the adult coloration. The former was stated as being a deep-colored green above with five (median dorsal, two dorsolateral, two lateral) whitish or yellowish lines. The lateral fields (between the dorsolateral and lateral pale lines) are dark brown. In adults, the lines disappear and the general dorsal coloration becomes a more or less dull ashy green. The coloration of the sides is changed into lenticular black spots, which form a not particularly clear, undulating black longitudinal band (the lateral fields). The ventral surfaces in the adult are greenish yellow. The figure of *Ameiva auberi* in the Atlas of the de la Sagra work shows a dorsally unlined lizard with the back grayish green, lateral fields bounded above and below by dirty white lines, scattered large black blotches in a grayish tan lateral field, a gray belly, and a greenish-gray throat. No population of *A. auberi* with which I am familiar is characterized by the above combination of color and pattern.

Since it is mandatory to restrict the type locality of *A. auberi* Cocteau, I have corresponded with Jean Guibé of the Muséum National d'Histoire Naturelle, in which it might be assumed the original material of *A. auberi* is deposited. In response to my query, Dr. Guibé replied that there are four specimens (MNHN 1112, 2647, 1788, and 4178) that came from Cuba and were given to the collection by Ramón de la Sagra. These four lizards are considered in the catalogue to be the syntypes of *A. auberi*. However, none of them corresponds with the measurements given by Cocteau (1838 or 1839:51). Cocteau's most pertinent measurements are a total length of 260 mm. and a tail of 170 mm., giving a snout-vent length of 90 mm.

Dr. Guibé further stated that MNHN 4178 is probably the specimen later described in detail by Duméril and Bibron (1839:111 *et seq.*), but as noted above, it does not agree with the data given by Cocteau.

The problem thus resolves itself into the precise status of these four specimens. The evidence for their being syntypes seems inconclusive. Since none of the four lizards agrees in dimensions or in pattern with Cocteau's detailed data, plate, and description, and since often in that

period of zoological research the ultimate importance of typical material was unrecognized — with the result that the designation of these four lizards as syntypes may have been made much later than the appearance of both the de la Sagra and Duméril and Bibron works — I have disregarded these four lizards (of which I have examined MNHN 1788 and 2647) as indicators of the provenance of the specimens on which the name *A. auberi* was based.

The situation is thus anomalous. The "syntypes" themselves do not agree with the details as given by Cocteau, and the Cocteau description and plate do not agree with any known population of *A. auberi.* However, the following comments are pertinent.

Cocteau (1838 or 1839:51) stated that *Ameiva auberi* was named for Don Pedro Auber of the Jardín botánico de la Habana. Since these lizards even now are moderately abundant in the La Habana region, it would seem not improbable that Auber collected the original specimens in this general area. The two Paris specimens that I have examined do not agree in any way with La Habana material but do agree in scale counts, coloration, and pattern with recent material from the southern third of the Isla de Pinos. Conde (1958a:78) stated that among many other contributors to de la Sagra's work was A. H. Lanier (the French consul at Trinidad, Cuba), who explored the Isla de Pinos in 1831 (Jennings, 1917:22). Since Lanier made a collection of plants for de la Sagra on the Isla de Pinos it is not improbable that he may have collected a few other natural-history specimens there also. Thus, the two Paris specimens I examined may well have come from the Lanier collections from Isla de Pinos, but there is no assurance that these two (or the remaining two) were before Cocteau when he named *Ameiva auberi.*

Everything considered, I have placed most emphasis on two facts stated by Cocteau: (1) that the species was named for Auber, who resided in La Habana, and (2) that no mention was made of a black throat on any of the syntypes, especially the large individual for which measments and detailed description were given. Since the recently taken material from Habana Province lacks a black throat (a very striking feature where it occurs), in at least this one feature the fresh material resembles Cocteau's description. I therefore restrict the type locality of *Ameiva auberi* to the vicinity of La Habana, Habana Province, Cuba. If, in the future, the status of the supposed syntypes can somehow be established without doubt, and they (or some of them) are considered to have originated on the southern portion of the Isla de Pinos, a nomenclatorial shift alone will be required. The northern coastal population in Habana Pro-

vince will require a new name, and the name I have proposed in the present paper for the southern Isla de Pinos population will become *A. a. auberi.*

With the above restriction, the population of *Ameiva auberi* in northern Habana and Matanzas provinces becomes the nominate race. Although heretofore I have begun the systematic treatment of *Ameiva* (from Hispaniola) with a discussion of the nominate form, I depart from this more logical procedure here. It seems preferable in this case to begin the discussions of the various subspecies with that of the race at the extreme western end of the island and proceed eastward. Such a method permits the placement of *A. a. auberi* in its proper geographic position relative to the subspecies to the east and west.

Ameiva auberi may be defined as follows (data from both Cuban and Bahamian populations combined):

Characteristics and Variation

(1) a moderate-to-large species of the genus *Ameiva* with snout-vent length to 136 mm. in males and 115 mm. in females; (2) dorsal caudal scales keeled and straight; (3) ventrals in 8 to 14 transverse rows (although the modal count is overwhelmingly 10, and counts of 8, 9, 11, 12, and 14 occur rarely and never characteristically in any subspecies) and in 28 to 36 longitudinal rows; (4) fourth toe subdigital scales from 61 to 94 – combined counts for both fourth toes; (5) femoral pores 20 to 35 – both series combined; (6) fifteenth caudal verticil with 22 to 37 scales; (7) dorsal pattern variable but consisting of either (a) a median and two dorsolateral pale lines enclosing between them the dorsal fields, which are some shade of brown, varying from pale-sandy or tannish gray to brown or rich reddish brown, or (b) more or less unicolor tans to browns dorsally without (or only faintly indicated) median and dorsolateral lines, and having the lateral fields black or brown, with varying amounts and patterns of red, brick-red, tan, or brown included in the lateral fields; (8) throat varying from cream or yellow to solid black, the black often extending posteriorly onto the abdomen for various distances; and (9) hemipenis extending to about the sixth to eighth caudal verticil, sulcate surface naked, sulcus bifurcating apically, the branches ending in two poorly defined apical discs, non-sulcate surface entirely flounced, the flounces extending to the margins of the sulcate surface, a small smooth triangular area on the non-sulcate side dividing the flounces for about one third the length of the organ into two fields of flounces which correspond to the apical discs.

In the following subspecies accounts, data have been given on size, rows of transverse and longitudinal ventrals, total number of fourth-toe scales, total number of femoral pores, scales in the fifteenth caudal verticil, and coloration and pattern. Emphasis has been placed on the last categories, and on size (snout-vent length). The meristic data from scale counts, although showing means which are often statistically significant *inter se* (see Table 4), offer no sure way of identifying any individual

specimen, but on the other hand offer differences between various populations. It should be recognized from the beginning of the accounts that such rankings as "high," "moderate," and "low" in regard to fourth-toe scales, femoral pores, and fifteenth verticil scales are arbitrary rankings according to the means of these counts. However, such scale characters are an additional way of quantifying the interpopulation differences and are moderately useful in defining subspecies.

The remarkable consistency in counts of longitudinal and transverse rows of ventrals renders them of no value in differentiating the subspecies. Despite transverse counts of 8, 9, 11, 12, and 14, the modal condition in all populations is very strongly 10 (see, however, the account of the subspecies from the northern Las Villas *cayeria*). The modal number of longitudinal rows of ventrals in all Cuban subspecies varies from 31 to 34. The modal condition in any population is not significant (with the exception that only one Cuban population has a mode of 31 and only two have modes of 34), since the range of variation in any given sample almost matches the entire range for this character (28 to 36) in all Cuban specimens studied. For example, in a sample of 85 specimens from between the Bahía de Santiago and the Bahía de Guantánamo, the range of longitudinal rows of ventrals is 30 to 36, and the sample of 57 specimens from the northern portion of the Isla de Pinos has longitudinal counts of from 29 to 34. In the former instance, the mode is 32, in the latter 31. It is obvious that this count is hardly valuable for diagnoses, but data are nevertheless presented in each subspecies account.

Attention should be directed to the throat coloration. Ten Cuban populations from (at times) widely separated regions are characterized by having black throats. In most cases, the black throat and chest color are fairly constant within a sample from a particular region. Males have the throat and chest black (although in two of the black-throated populations — near Trinidad in Las Villas, and in northern Matanzas — the throat is not completely black but has a black median blotch). Although it would be reassuring to be able in the case of these black-throated subspecies to state that "all adult males above a snout-vent length of such-and-such have black throats," such a statement is seldom completely true. In most cases some large and obviously adult males lack any indication of a black throat and chest, and this character may also appear randomly in smaller males far below the maximally sized individuals. Very rarely do females of these black-throated races have the throats as completely black as do the black-throated males. Throats of females resemble in intensity of pigment those of adult males that are just acquir-

ing the fully black throat and chest. Small subadults and juveniles of both sexes lack any indication of black throats. The details of the condition of black throats in each sex in those subspecies that are black-throated are discussed individually in each account. The above qualifications should be understood in advance.

In several populations (northern Oriente coast at Gibara, Cayo Cantiles in the Archipiélago de los Canarreos, Cayuelo de la Vela in the Archipiélago de Sabana off the northern coast of Las Villas) there are some peculiarities of throat pigmentation: at Gibara, there apparently occurs a non-black-throated population of a subspecies that elsewhere along this coast is black-throated, whereas in the two island chains of the Archipiélago de los Canarreos and Sabana, individual islands have black-throated populations or occasional black-throated lizards in otherwise non-black-throated areas. My treatment of these three anomalous instances has been arbitrary, primarily because in two cases (Gibara, Cayo Cantiles) I have seen little or no living material. In these two instances I have included the peculiarly colored lizards with their adjacent relatives, but this treatment is not necessarily correct. In the third case (Cayuelo de la Vela), I have chosen to distinguish the population there nomenclatorially. In each instance I have given my reasons for the course I have pursued. I have not mentioned here the situation on the southern portion of the Isla de Pinos, wherein the population may or may not have black throats, although there, if the throat is not black, that color is not replaced by red or orange, but is merely pale blue. Details of the southern Isla de Pinos lizards will be discussed later.

Aside from the anomalous populations mentioned above, all those subspecies that have the throat colored (in contrast to black) have it so regularly, without exception (subadults and females may have the throats somewhat paler than adult males). Thus, in over 60 specimens of the widespread race in Pinar del Río, the throat in all is uniformly yellow, and no specimen shows any indication of black pigment. From these circumstances, I deduce that some populations have the potential for ontogenetic development of black throats, whereas others lack it completely. This basic assumption has brought about the description of colored- and black-throated races that at times closely approximate each other geographically, and that at times also have relatively restricted distributions. Comments will be made in the appropriate places on such situations.

Recent workers on the related teiid genus *Cnemidophorus* have employed the number of dorsal granules at midbody as a character

useful for differentiation of species, and, to a more limited degree, of subspecies. Although in my previous studies on West Indian *Ameiva*, I have not used this count, in an effort possibly to give added data on subspecific differentiation in *A. auberi*, a set of pilot counts was taken on specimens from the two extremes of Cuba — Cabo de San Antonio and east of Guantánamo — plus specimens from the southern coast of Pinar del Río. The midbody granules vary from 89 to 112 in the lot counted. The series from Cabo San Antonio and east of Guantánamo have virtually identical extremes (91 to 112), whereas the lower counts (89 to 98) are from southern Pinar del Río. These data suggest that, as in *Cnemidophorus*, some subspecies of *A. auberi* might be partially definable on the basis of number of dorsal granules, but just as in other counts in this species, the dorsal granule differences are by no means absolute.

Maximum size of the various subspecies of *A. auberi* shows some striking differences. Sometimes there has been comment on the validity of using this character to differentiate races of teiid lizards, the premise being that the collector may simply not encounter fully adult specimens in the course of his activities. I feel strongly that such an assumption is incorrect. The very large size of specimens of *A. auberi* from Pinar del Río Province, for instance, whence long series are available, stands in contrast to the much smaller maximum size of a large number of specimens from southern Oriente between the Bahía de Santiago and the Bahía de Guantánamo. In the former region, males reach a snout-vent length of 136 mm. (with many males with snout-vent lengths in excess of 100 mm.), whereas in the latter region no male reaches a snout-vent length greater than 78 mm. Such differences hardly seem attributable to artifacts of collecting and sampling. To me the differences represent inherent genetic differences in size (and bulk) of the members of the populations involved. In none of the five large subspecies (one in Pinar del Río, two in northern Las Villas, two in southern Las Villas) exceeding 100 mm. snout-vent length in maximum size, are males represented by a single unusually large or "giant" male and a larger suite of much smaller males. In all cases there is graded series from small to very large males, with the largest specimen merely the end of a long and evenly graded series of males of increasing snout-vent lengths. From these observations, I consider that size is a perfectly valid character for differentiation of subspecies in *Ameiva*.

SYSTEMATIC REVIEW

Ameiva auberi cacuminis, new subspecies

HOLOTYPE: AMNH 83028, an adult male, from Ensenada de Cajón, Pinar del Río Province, Cuba, taken December 22, 1958, one of a series collected by Armando García, Ronald F. Klinikowski, Donald R. Price, Frank C. Sentz, Jr., and Albert Schwartz. Original number 7072.

PARATYPES (all from Pinar del Río Province, Cuba): AMNH 96311-96320, same data as holotype; USNM 51790, Cabo de San Antonio, May 23, 1914, J. B. Henderson and P. Bartsch; USNM 51795, Cabo de San Antonio, May 23, 1914, J. B. Henderson and P. Bartsch; USNM 51851-51852, Cabo de San Antonio, May 26, 1914, J. B. Henderson and P. Bartsch; MCZ 10868, Cabo de San Antonio, April, 1915, V. D. Rodríguez; IB 135, La Tumba, January 19, 1966, O. H. Garrido.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of small size (males to 80 mm., females to 60 mm. snout-vent length), moderate number of fourth-toe subdigital scales, femoral pores, and scales in the fifteenth caudal verticil; dorsum brown with an inconspicuous median yellow line in adults, brown with prominent lemon-yellow line in subadults and juveniles, lateral fields black with irregular red edges; and throat dusky gray.

DISTRIBUTION: Known only from the extreme tip of Cabo de San Antonio, Pinar del Río Province, Cuba; all distributions shown in Fig. 1.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 72 mm., tail 167 mm.; ventrals in 32 longitudinal and 10 transverse rows; fourth-toe subdigital scales 41 and 42 (total 83); femoral pores 14 and 14 (total 28); 27 scales in the fifteenth caudal verticil. Dorsal ground color brown in life, with the median and two dorsolateral lines inconspicuously yellow; lateral fields vaguely outlined above by the dorsolateral yellowish lines, solid black with irregular red edges. Throat dusky gray; venter dull grayish blue. Tail grayish blue above, slightly brighter below, with ventrolateral white stripe moderately conspicuous along the basal third of tail. Limbs brown above, with some very vague darker marbling.

VARIATION: The series of 17 specimens of *A. a. cacuminis* has the following counts: longitudinal ventrals 30-33 (mode 32); rows of transverse ventrals 10 in all specimens; fourth-toe scales 66-83 (mean 75.1); femoral pores 24-29 (mean 25.6); fifteenth verticil 24-29 (mean 26.4). The largest male has a snout-vent length of 80 mm., the largest female (the only adult female in the series) 60 mm.

The longest series of paratypes was collected by myself and party in 1958. In life, these specimens were recorded as being brown dorsally, with the median dorsal line lemon yellow in juveniles and subadults, and less conspicuously yellow in adults. In all there is no indication of a black throat, the throats being dusky gray. The lateral fields are solid black without any interior red dotting; red pigment occurs only along the edges of the lateral fields as a series of ragged and irregular scallops or blotches. The USNM, MCZ, and IB paratypes (of which USNM 51851 is the largest male and USNM 51795 is the largest female)

agree well with the fresh material, except that one specimen (USNM 51851) has a few isolated red dots in the lateral fields, and the edges of the fields are somewhat more extensively red than in all other specimens. No lizard has any indication of black on the throat or chest.

REMARKS: The series from the type locality was collected in xeric forest along the coast of the Ensenada de Cajón. Few adults were seen, although juveniles were quite abundant in the woods and along the beach front.

Ameiva auberi denticola, new subspecies

HOLOTYPE: AMNH 79202, an adult male, from north shore, Ensenada de Corrientes, Pinar del Río Province, Cuba, taken July 10, 1957, one of a series collected by John R. Feick, Armando García, and William H. Gehrmann. Original number 2618.

PARATYPES (all from Pinar del Río Province, Cuba): AMNH 79200-79201, 79203-79231, same data as holotype; AMNH 78391, 79189-79199, same locality as holotype, July 5, 1957, J. R. Feick, A. García, W. H. Gehrmann; MCZ 55552, Ensenada de Corrientes, July 4, 1956, K. F. Koopman; AMNH 83026 (13 specimens), north shore, Ensenada de Corrientes, about 40 km. W. Cayuco, August 19, 1958, A. García, A. Schwartz, G. R. Zug; AMNH 83027 (7 specimens), north shore, Ensenada de Corrientes, about 45 km. W. Cayuco, August 19, 1958, A. García, A. Schwartz, G. R. Zug; AMNH 79187-79188, western coast, Cabo Corrientes, July 5, 1957, J. R. Feick, W. H. Gehrmann; AMNH 79232, western coast, Cabo Corrientes, July 10, 1957, A García.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of large size (males to 96 mm., females to 78 mm. snout-vent length), moderate number of fourth-toe subdigital scales, high number of femoral pores and scales in the fifteenth caudal verticil; dorsum olive-tan, unicolor in adults and with the median and dorsolateral lines yellowish in juveniles and subadults, lateral fields variable but most often with the black extremely restricted to a series of discrete blotches in the lateral field area and with consequent extensive reddish areas along the margins of the fields; and throat and chest black.

DISTRIBUTION: The Península de Guanahacabibes, from the western shore of Cabo Corrientes west to about 45 km. west of Cayuco, Pinar del Río Province, Cuba.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 96 mm., tail 187 mm., tip regenerated; ventrals in 32 longitudinal and 10 transverse rows; fourth-toe subdigital scales 39 and 38 (total 77); femoral pores 15 and 16 (total 31); 29 scales in the fifteenth caudal verticil. Dorsum olivaceous tan, with no indications of median or dorsolateral lines; lateral fields much reduced, consisting of a linear series of small and rather disjunct black blotches bordered above and below with reddish. Lower sides olivaceous, somewhat mottled with greenish and not set off from the lateral fields by pale lateral lines. Throat and chest black, the black extending to about the level of the fourteenth row of ventrals, although more diluted, and restricted to the margins of the ventrals posteriorly; venter bright blue laterally, lighter and grayer centrally. Limbs concolor with dorsum on upper sides, forelimbs dark

blue-gray ventrally, hindlimbs blue ventrally. Tail olivaceous blue above, purer blue below; ventrolateral pale caudal stripe absent.

VARIATION: The series of 59 specimens of *A. a. denticola* has the following counts: longitudinal ventrals 31-34 (mode 32 or 33); rows of transverse ventrals 10, 12 (2 specimens), or 14 [(1 specimen) (mode 10)]; fourth-toe scales 67-86 (mean 76.4); femoral pores 23-31 (mean 27.1); fifteenth verticil 24-33 (mean 28.0). The largest male has a snout-vent length of 96 mm. and the largest female 78 mm.

The long series of adult paratypes agrees with the description of the holotype in all details except the condition of the lateral fields. Although the modal condition is as described for the holotype — a series of disjunct black blotches bordered above and below by dull reddish areas — at times the lateral fields may be more complete and have a discrete reddish border both above and below, enclosing a more or less irregular and sinuous black "line" from the neck to the groin. Occasional specimens have the lateral fields solid black, or solid black with a very few isolated reddish dots. The ventrolateral caudal stripe is absent in adults.

Subadults and juveniles are lineate dorsally, the lines yellowish and not especially contrasting to the olive ground color. The lineate condition is pronounced only in juveniles, and by the time a snout-vent length of about 70 mm. is reached, most subadults have the dorsum unicolor and patternless like that of the much larger adults.

Since *A. a. denticola* is a black-throated race, special comment is required. All adult and subadult specimens (37 males and 21 females) were graded into three categories: (1) throat and chest completely black; (2) throat and chest only partially black; and (3) throat and chest without black. All specimens (15) in category 1 are males, ranging in snout-vent lengths from 64 mm. to 96 mm. (thus including the largest male). Category 2 includes 12 males and 9 females. The males range in snout-vent length from 70 mm. to 93 mm. (and are thus bracketed in size by the males of category 1), and the females from 56 mm. to 75 mm. (thus not including the largest female). Category 3 includes 11 males with snout-vent lengths from 66 mm. to 90 mm., and 12 females from 58 mm. to 78 mm. (thus including the largest female). From these data it is obvious that most males (27 of 37) have some black on the throat and chest, but that black pigment is not restricted to large specimens. In females, only nine of 21 specimens have black on the throat and chest, and in *denticola* the black pigment in females is never as extensive as it is in males. These peculiarities are difficult to analyze. All specimens are summer-collected, so it is possible that here (and in the other black-throated races) the black-throated coloration is somehow

correlated with season (see comments below) or with sexual activity. If the latter is the case, it seems strange that a small male with a snout-vent length of only 64 mm. would be sexually mature. My suggestion is that the black chest and throat may appear in males of the black-throated subspecies at any size once the early juvenile condition is past. Thus, some individuals become black-throated at a small size and others achieve this state only with a much larger size. This implies that males without a black chest and throat at a larger size (for instance, 90 mm., the largest non-black-throated male in the present lot of specimens) have still to reach this condition.

The situation in females is comparable, although in *denticola* there is no evidence that females are ever completely black-throated and black-chested. The fact that the largest female of the series lacks any black pigment suggests that this lizard has still not reached that condition but would ultimately have done so.

In arguing against the premise that possession of black throats is a seasonal phenomenon, I note here that in other black-throated races where specimens have been collected in both winter and summer, there is no difference in frequency of black-throated lizards by season.

COMPARISONS: The races *cacuminis* and *denticola* can be distinguished by three features: (1) the former is brown dorsally, the latter olivaceous tan; (2) the former is gray-throated, the latter black-throated and black-chested; (3) the former has a solid black lateral field, the latter has the lateral field usually very much reduced and fragmented.

Of all the races of *A. auberi*, only *denticola* has such a wide variation of number of transverse rows of ventrals, although the modal condition of 10 rows is strong. Only two lizards (AMNH 79215 and 79221) have counts of 12 rows, and one (AMNH 79219) has a count of 14. These variants are purely casual and have no taxonomic significance.

REMARKS: The area whence most of the specimens of *A. a. denticola* were secured is a xeric region of sandy soils and *diente de perro* (dog's tooth — hence the name *denticola*) eroded limestone on the Península de Guanahacabibes. The large number of specimens of *denticola* attests to the abundance of ground lizards in this particularly favorable habitat. The series from 40 km. west of Cayuco was taken in *monte* (lowland broadleaf forest) in a more mesic situation than the purely coastal situations, and rather more mesic than those woods occupied by *cacuminis* at the tip of the peninsula.

The differentiation of *A. auberi* into two subspecies on the Península de Guanahacabibes is difficult to explain, but the same phenomenon will be observed later on the much shorter and more attenuate Península de Hicacos in Matanzas Province. Actually, all records for *denticola* are on the southern coast about the Ensenada de Corrientes, whereas the records for *cacuminis* are on the northern coast. In 1960, David Leber and I collected between Cayuco and the Valle de San Juan in apparently suitable habitats. The road in this region is about equidistant from the north and south shores of the peninsula. No *Ameiva* were seen. It is possible that *cacuminis* and *denticola* represent north- and south-shore subspecies on the peninsula, rather than basal and distal subspecies. The lack of specimens from the more central portions (latitudinally) of the Península or the more distal region (longitudinally) precludes any definite resolution of the problem.

Certainly the Península de Guanahacabibes is a significant region zoogeographically. From it have been described one endemic species (*Anolis quadriocellifer* Barbour and Ramsden) and several endemic subspecies of more widely ranging reptiles (*Leiocephalus carinatus zayasi* Schwartz, *Leiocephalus stictigaster stictigaster* Schwartz, *Leiocephalus macropus koopmani* Zug, *Dromicus andreae peninsulae* Schwartz and Thomas). The peninsula is generally, despite its relatively poor rainfall of 115 to 125 cm. per year (Marrero, 1951:442), well wooded, and at the time of my last visit in 1960, was more or less uncultivated, especially to the west. There are several sinkhole lakes, such as that at Vallecito de San Juan, which are surrounded by luxuriant broadleaf trees with epiphytes and lianas. Such interior wooded regions contrast strongly with the more bleak and arid southern coastal portion about the Ensenada de Corrientes. To the east, the peninsula abuts upon the flat, lake-studded plains of southwestern Pinar del Río (see Marie-Victorin and Léon, 1944:132-33 and 302-04 for typical photographs of this interesting region). These plains are inhabited by the following subspecies of *A. auberi.*

Ameiva auberi procer, new subspecies

HOLOTYPE: AMNH 78390, an adult male, from San Vicente, Pinar del Río Province, Cuba, taken June 24, 1957 by Albert Schwartz. Original number 1857.

PARATYPES (all from Pinar del Río Province, Cuba): AMNH 79153, same locality as holotype, June 20, 1957, native collector; AMNH 79165, same locality as holotype, June 28, 1957, native collector; AMNH 79167, same locality as holotype, June 30, 1957, native collector; AMNH 79168-79172, same locality as holotype, July 5, 1957, native collector; AMNH 79173-79179, same locality as holotype, July 6, 1957, native collector; AMNH 79180, same locality as holotype,

July 8, 1957, native collector; AMNH 79181, same locality as holotype, July 9, 1957, native collector; AMNH 79182-79186, same locality as holotype, July 10, 1957, native collector; AMNH 83005 (3 specimens), same locality as holotype, August 7, 1958, native collector; AMNH 83024 (9 specimens), same locality as holotype, August 8, 1958, native collector; AMNH 83029 (2 specimens), same locality as holotype, December 26, 1958, R. F. Klinikowski; AMNH 79150-79152, mountains north of San Vicente, June 19, 1957, D. R. Paulson; AMNH 79166, mountains north of San Vicente, June 29, 1957, native collector; AMNH 83004 (2 specimens), 0.5 mi. N. San Vicente, August 5, 1958, G. R. Zug; AMNH 76553-76554, mountains behind (N.W.) San Vicente, December 28, 1956, W. H. Gehrmann; MCZ 55570-55571, near Viñales, July 9-10, 1956, K. F. Koopman.

ASSOCIATED SPECIMENS (all from Pinar del Rio Province, Cuba): AMNH 96323, 8.2 mi. W. Cayuco; AMNH 96321-96322, 6.9 mi. W. Cayuco; AMNH 83025 (2 specimens), 1 mi. N.W. Cayuco; AMNH 83944, 13 mi. S.W. Isabel Rubio; AMNH 79160-79162, 11.3 mi. S.E. Isabel Rubio; AMNH 79163-79164, 2.9 mi. E. Isabel Rubio; AMNH 79154-79159, 7.6 mi. E. Isabel Rubio; IB 1358, San Waldo, 4 km. N. Cortés, road between Cortés and Isabel Rubio (not mapped); MCZ 10833, Guane; USNM 27368-27371, El Guamá; MCZ 7938, San Diego de los Baños; IB 141, Dayaniguas; MCZ 4388, Bahía Honda; USNM 27662-27663, 27676-27683, Cabañas.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of very large size (males to 136 mm., females to 115 mm. snout-vent length), low number of fourth-toe subdigital scales, moderate number of femoral pores, high number of scales in the fifteenth caudal verticil; dorsum brown, unicolor in adults and subadults but juveniles showing median and dorsolateral yellow lines, lateral fields with more black than red, the red pigment usually forming a series of dorsal and ventral scallops along the upper and lower borders of the field with each lower scallop about two to three times the area of each dorsal scallop; and throat and chest yellow.

DISTRIBUTION: Pinar del Río Province, from the vicinity of Cayuco in the southwest, north at lower elevations (about 1000 feet) in at least the southern and central portions of the Sierra de los Organos and Sierra del Rosario, as far east as San Diego de los Baños and Dayaniguas on the south coast, and north on the coast to Bahía Honda and Cabañas.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 119 mm., tail 267 mm.; ventrals in 34 longitudinal and 10 transverse rows; fourth-toes missing; femoral pores 14 and 14 (total 28); 27 scales in the fifteenth caudal verticil. Dorsal ground color brown in life, with no indications of median or dorsolateral lines; lateral fields prominent and bold, consisting of a black sinuous band with both dorsal and ventral brick-red scallops, the ventral scallops about three times the size of the dorsal scallops; ventral scallops separated by ventrad extensions of black pigment and thus more or less discrete. Lower sides blue, mottled with irregular and somewhat tigroid blackish blotches; blue of sides continuous onto venter, involving chest (where blue is admixed with yellow) and all enlarged ventral scales except the paramedian rows. Anterior faces of hindlimbs and sides of tail bluish gray, with a white ventrolateral stripe on the proximal third of the tail; cheeks, throat, sublabials (and chest, where admixed with bluish gray) yellow. Limbs grayish brown much marbled

with black above, and pale blue-gray to yellowish below.

VARIATION: The series of 62 specimens of *A. a. procer* has the following counts: longitudinal ventrals 31-35 (mode 33); rows of transverse ventrals 8 (3 specimens), 9 (1 specimen) or 10 (mode 10); fourth-toe scales 63-84 (mean 71.9); femoral pores 21-31 (mean 26.0); fifteenth verticil 24-31 (mean 27.3). The largest male has a snout-vent length of 136 mm., the largest female 115 mm.

The large lot of *A. a. procer* agrees well with the description of coloration and pattern of the holotype. The major variation is in the lateral fields. The holotype represents the modal condition. Occasional individuals have the red pigment so much expanded that the black areas are restricted to irregular blotches in an otherwise brick-red field. In all fresh specimens, the throats (and chests, unless they are additionally overlaid with grayish) were yellow, and no specimen shows any tendency toward the black throat of *denticola* to the southwest. Specimens from the vicinity of Cayuco, however, show a tendency toward having the throats orange rather than yellow.

The unlined dorsum is a constant feature of adults. In juveniles and males to snout-vent lengths of about 80 mm. and females to about 87 mm., the usual juvenile pattern of a median and two dorsolateral yellowish lines is displayed.

COMPARISONS: *A. a. procer* differs from both *cacuminis* and *denticola* in having a yellow throat (in contrast to dusky gray and black throats), and in being much larger than either of the two more western subspecies. In fact, *procer* is the largest of any Cuban subspecies of *A. auberi*. The brown dorsum of *procer* contrasts with the olive-tan dorsum of *denticola* but is like the brown back of *cacuminis*.

Although as usual the modal number of transverse rows of ventrals is 10 in *procer*, three specimens have counts of 8 rows, and one has an irregular count of 9.

REMARKS: *A. a. procer* occupies a wide variety of situations, from the flat, grassy, lake-studded plains between Isabel Rubio and Cayuco in the southwest to the southern slopes and interior of the Sierra de los Organos and Sierra del Rosario to elevations of 1000 feet. In these mountain ranges, as noted in the introduction, *Ameiva* occupies the valley floors and the drier uplands, and not the heavily wooded and mesic *mogote* sides and tops or associated rich forests. *A. a. procer* is common in the vicinity of San Vicente, occurring there along the roadsides and in cane fields and truck gardens. Most of the series of paratypes were collected by native boys while cutting sugar cane. In the mountains to the north and northeast of San Vicente, the lizards are less abundant in the rather more arid woods that occupy gravelly soils.

Specimens from 7.6 miles east of Isabel Rubio were taken in riparian growth along a small stream in a pasture, and those from 13 miles southwest of Isabel Rubio were collected along the margin of a lake in a dry pasture. The specimens from 1 mile northwest of Cayuco were taken from a well-shaded *encinal* with palmetto undergrowth.

Barbour (1914:309) reported the occurrence of *A. auberi* at Herradura and Pinar del Río city, but no specimens are available from either locality. The latter record almost certainly pertains to *A. a. procer*, which may also occur at Herradura, although that area might be occupied by the following subspecies.

There is no evidence of intergradation between *procer* and *denticola*, although it is to be expected between the westermost record of *procer* (8.2 mi. W. Cayuco) and the easternmost record of *denticola* (western coast, Cabo Corrientes), a distance of about 16 kilometers. It is possible that *denticola* occupies only the arid coastal section of the Península de Guanahacabibes, and *procer* the more mesic plains about Cayuco, and that the zone of intergradation between the two forms is rather narrow and restricted to the region where these two habitats come in contact with one another. The relationships of *A. a. procer* to the race to the northeast will be discussed under that form.

Ameiva auberi paulsoni, new subspecies

HOLOTYPE: AMNH 83012, an adult male, from 1 km. N. Las Canas, Pinar del Río Province, Cuba, taken August 7, 1958, one of a series collected by Albert Schwartz and George R. Zug. Original number 6329.

PARATYPES (all from Pinar del Río Province, Cuba): AMNH 83013-83023, same data as holotype; AMNH 96325-96329, 1 km. E. Las Canas, June 23, 1960, D. C. Leber, A Schwartz; AMNH 78386-78389, 1 km. N. La Coloma, June 25, 1957, J. R. Feick, W. H. Gehrmann, D. R. Paulson; AMNH 83006-83011, 1 km. N. La Coloma, August 7, 1958, A. Schwartz, G. R. Zug; AMNH 96324, 1 km. N. La Coloma, June 23, 1960, D. C. Leber.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of moderate size (males to 92 mm., females to 75 mm. snout-vent length), low number of fourth-toe subdigital scales, femoral pores, and scales in the fifteenth caudal verticil; dorsum reddish brown with bright lemon-yellow median and dorsolateral lines in adults, lateral fields black with a series of small red dots or scallops along only the ventral border of the fields; and throat cream colored.

DISTRIBUTION: Known only from the vicinity of Las Canas and La Coloma on the south-central coast of Pinar del Río Province, Cuba.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 92 mm., tail (incomplete and regenerated) 123 mm.; ventrals in 34 longitudinal and 10 transverse rows; fourth-toes missing; femoral pores 12 and 13 (total 25); scales in the fifteenth caudal verticil damaged. Dorsal ground color reddish brown in life, with bright lemon-yellow median and dorsolateral lines, the latter extending onto the basal portion of tail as a dorsolateral pair

of yellowish streaks; lateral fields black with a series of discrete reddish dots along their lower borders only, and extending behind the hindlimbs onto the sides of the tail as a broad black lateral stripe; lower sides tigroid blue-gray and darker gray; venter very pale blue centrally and darker grayish blue laterally. Throat cream; chest cream with some very pale bluish suffusions and a few isolated blackish flecks on the third and fourth transverse rows of ventral scales. Upper surface of forelimbs and hindlimbs reddish-brown, with black tigroid markings. Tail deep blue above, with dorsolateral yellowish lines, bordered below by the black lateral streak, which in turn is bordered below by a bold white ventrolateral stripe; under side of tail pale blue.

VARIATION: The series of 28 *A. a. paulsoni* has the following counts: longitudinal ventrals 30-34 (mode 32); rows of transverse ventrals 10 in all specimens; fourth-toe scales 61-77 (mean 68.6); femoral pores 20-28 (mean 24.2); fifteenth verticil 24-27 (mean 25.6). The largest male has a snout-vent length of 92 mm., the largest female 75 mm.

In all details of pattern and coloration, the series of *A. a. paulsoni* is very consistent. The striking configuration of the lateral fields is especially noteworthy and is a regular feature of the series. No lizard shows any tendencies toward having the throat any color (including black) other than cream. The persistence of the lineate dorsal pattern into full adulthood in both sexes is an outstanding character.

COMPARISONS: *A. a. paulsoni* can be differentiated by its cream-colored throat from the races *cacuminis* (dusky gray), *denticola* (black), and *procer* (yellow). *A. a. paulsoni* is larger than *cacuminis*, about the same size as *denticola*, and distinctly smaller than its relative *procer* to the north, west, and east. The lateral field pattern of a row of reddish dots along the ventral border of the fields is characteristic of *paulsoni* and occurs in no other subspecies. In addition, the reddish-brown dorsal coloration and persistent dorsal lines distinguish *paulsoni* from the other western subspecies. *A. a. paulsoni* has the lowest mean of fourth-toe scales of all Cuban subspecies of *A. auberi*, and the means of femoral pores and fifteenth verticil scales are also low.

REMARKS: The region whence *A. a. paulsoni* is known is occupied by two endemic subspecies of other wide-ranging Cuban species of reptiles — *Anolis sagrei bremeri* Barbour and *Tropidophis melanurus dysodes* Schwartz and Thomas. La Coloma lies in a region of low and rather moist palm savannas on the Llanura Costera del Sur de Pinar del Río (Marrero, *op cit.*:430 *et seq.*). The Las Canas lizards were taken on wet sand about a garbage dump adjacent to a borrow-pit pond and rather near the coast. The Llanura Costera del Sur is a region of low average rainfall (115 to 140 cm. annually), but the general aspect of the countryside is not arid. Stands of palms (including *Sabal parviflora*, *Cameraria retusa*, and *Colpothrinax wrighti*) and occasion-

al pines occur in wide areas of open grassy flats, which give an almost cultivated and pastoral aspect to the region.

The complete distribution of *A. a. paulsoni* doubtless is more extensive than indicated by the three adjacent localities whence it has been taken. Although I have collected on the southern Pinar del Río coast to the east of the known range of *paulsoni* at Herradura, and to the west at Punta de Cartas and San Juan y Martínez, no *Ameiva* were observed at either locality. The localities for *paulsoni* are about 42 kilometers airline from the nearest locality of *procer* to the west (7.6 mi. E. Isabel Rubio), about 46 kilometers airline from the nearest *procer* locality to the northeast (San Diego de los Baños), and about 38 kilometers from the nearest *procer* to the east (Dayaniguas).

Ameiva auberi auberi Cocteau

Ameiva auberi Cocteau, 1838 or 1839, *in* de la Sagra, *Historia física, Política y natural de la Isla de Cuba*: 51.

Ameiva trilineata Gray, 1845, Catalogue of specimens of lizards in British Museum:19.

TYPE LOCALITY: Cuba; restricted to the vicinity of La Habana, Habana Province, Cuba.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of moderate size (males to 92 mm., females to 88 mm. snout-vent length), moderate number of fourth-toe subdigital scales, and high number of femoral pores and scales in the fifteenth caudal verticil; dorsum rusty brown to brown in adults, juveniles with a vivid lemon-yellow median dorsal stripe, lateral fields with much red pigment, the black areas usually forming a reticulum; and throat orange.

DISTRIBUTION: The north coast of Cuba, from Marianao and La Habana on the west, east to the vicinity of Canasí, Matanzas Province, on the east, but see discussion below.

VARIATION: The series of 33 *A. a. auberi* has the following counts: longitudinal ventrals 32-35 (mode 32); rows of ventrals 10 in all specimens; fourth-toe scales 68-89 (mean 76.3); femoral pores 23-31 (mean 26.6); fifteenth verticil 26-31 (mean 28.2). The largest male has a snout-vent length of 92 mm., the largest female 88 mm.

In living material, the dorsal ground color of *A. a. auberi* varies from rusty brown to brown; the back is unicolor and without longitudinal lines. In juveniles there is a vivid yellow median dorsal line and somewhat less obvious dorsolateral yellow lines, all of which persist in various degrees of intensity into subadults. The lateral fields are reddish, and usually this pigment is so extensive that the black in the lateral field is reduced to a black reticulum or to a linear series of practically discrete black blotches. The lower sides are blue (Pl. 26 L 1; all color designations from Maerz and Paul, 1950) and this color extends onto

the ventral scales, the more central rows of which are much paler. The throat and chin are orange (Pl. 10 J 9, Pl. 9 B 12), somewhat lighter (almost yellow) on the cheeks, and the axillae and chest are likewise orange. The orange chest coloration may extend as a pinkish wash over the blue of the venter as far as the vent, onto the under side of the hindlimbs and tail, and onto the inner surface of the forelimbs. Juveniles have the bellies pink, the throats yellow to pinkish, and tails vivid blue, whereas the tail in adults is brown above and grayish blue to purplish below. The ventrolateral pale tail stripe is whitish to grayish, and not especially prominent in adults.

COMPARISONS: *A. a. auberi* differs from all other described subspecies in having the throat orange, and often having an orange wash over the venter and underside of the hindlimbs. No specimens show any tendency toward having a black throat or chest, although there are often a few scattered gray scales in the otherwise brightly colored throat. In dorsal coloration, lack of persistent dorsal stripes, and restriction of the black in the lateral fields, *auberi* most closely resembles *procer* to the west. The very large size and yellow throat of *procer* contrast with the smaller size and orange throat of *auberi.*

REMARKS: *A. a. auberi* occurs along the north coast of Habana and Matanzas provinces. I have encountered no specimens in any situations except coastal habitats — seagrape stands and on beaches at the base of the sea cliffs that abound in this stretch of coastline. There are specimens in collections from La Habana and its suburbs (Marianao, Regla) that indicate that ground lizards are in part urban in this area, and may occur some short distance inland from the ocean proper. Barbour's (1914:309) reports of *A. auberi* from two localities in Habana Province — Cojímar and Madruga — are unsubstantiated by specimens. The first locality is within the known range of *A. a auberi* (between La Habana and Boca de Jaruco) and the second lies on the Habana-Matanzas border, inland about 60 kilometers from the coast. I have seen no lizards from this general region and the assignment of *Ameiva* from Madruga to any specific subspecies must await material. I suspect that they will be found to be black-throated and black-chested like the subspecies next to the east of *A. a. auberi.*

SPECIMENS EXAMINED: *Cuba, Habana Province,* Marianao, 1 (USNM 28007); La Habana, 4 (USNM 58486-58488, AMNH 65599); Regla, 1 (USNM 128105); 2 mi. E. Playa de Guanabo, 2 (AMNH 78021-78022); Boca de Jaruco, 2 (AMNH 78027-78028); 2 mi. E. Boca de Jaruco, 9 (AMNH 78023-78026, 82946 – 2 specimens, AMNH 96330 – 3 specimens); Santa Cruz del Norte, 4 (IB 137-140); Playa Jibacoa, 6 (IB 1296-1301); *Matanzas Province,* 5.5. mi. N.E. Canasí, 5 (AMNH

82944 – 5 specimens); 6.6 mi. N.E. Canasí, 2 (AMNH 82945 – 2 specimens).

There are eight specimens from northeastern Pinar del Río Province that are anomalous: USNM 27617-27618 and USNM 27668-27671 from Mariel, and AMNH 82964-82965 from 5 km. north of Mariel. The first two lots are old specimens and are much discolored. The last two specimens were collected by myself. As far as can be determined from the old specimens, the males from Mariel are characterized by having at least a black chest (males with snout-vent lengths from about 70 mm. to 87 mm.). One of the recently collected males (snout-vent length 73 mm.) also has indications of a black chest. The single female appears not to have had any black chest or throat pigment. The throats of the two recently collected males (snout-vent lengths 80 and 73 mm.) were recorded as dirty cream and grayish. The dorsa of adults were apparently some shade of brown, and the subadults show some indication of lines. Since *procer* with a yellow throat occurs to the west at Cabañas, and *auberi* with an orange throat to the east at Havana, it seems that there is interposed between these two races a black-chested subspecies (neither of the two adjacent populations ever has any indication of a black chest or throat). I withhold any subspecific designation on the specimens from Mariel until additional fresh material from the northeastern portion of Pinar del Río Province and the extreme northwestern portion of Habana Province becomes available.

Ameiva auberi pullata, new subspecies

HOLOTYPE: AMNH 82953, an adult male, from 13 km. N.E. Matanzas, Matanzas Province, Cuba, taken June 13, 1958, one of a series collected by Albert Schwartz and G. R. Zug. Original number 5147.

PARATYPES (all from Matanzas Province, Cuba): AMNH 82949-82952, 82954-82963, same data as holotype; AMNH 83747-83748, same locality as holotype, June 18, 1959, A. Schwartz, B. L. Smith; AMNH 83947-83948, 6 km. N.E. Matanzas, June 13, 1958, A. Schwartz, G. R. Zug; IB 136, nr. Matanzas, March 23, 1965, J. de la Cruz; AMNH 32306-32308, Cárdenas, January 11, 1927, J. A. Weber.

ASSOCIATED SPECIMENS: AMNH 82966-82969, 1.6 mi. N. San Miguel de los Baños, Matanzas Province, Cuba.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of small size (both males and females to snout-vent length of 81 mm., but see discussion below), moderate number of fourth-toe subdigital scales, high number of femoral pores, and moderate number of scales in the fifteenth caudal verticil; dorsum brown, adults unicolor or with faint yellow median and dorsolateral lines, juveniles prominently lined with yellow, lateral fields with black restricted to a series of vertical bars (often absent anteriorly), and red areas almost completely replaced by tan-to-brown, practically concolor with dorsum; throat with a black median spot, and chest black.

DISTRIBUTION: From the vicinity of the city of Matanzas east to Cárdenas (but excluding the distal half of the Península de Hicacos), and presumably inland as far as the vicinity of San Miguel de los Baños (see discussion) in Matanzas Province, Cuba.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 78 mm., tail 163 mm.; ventrals in 33 longitudinal and 10 transverse rows; fourth-toe subdigital scales 38 and 38 (total 76); femoral pores 14 and 14 (total 28); 25 scales in fifteenth caudal verticil. Dorsum brown with median and dorsolateral yellow lines very faint but present; lateral fields obscure and composed of about 8 to 10 very reduced black vertical bars or dots on the posterior half of the trunk, the balance of the fields completely obscured by tan pigment. Chest black, pigment extending onto anterior and ventral faces of forelimbs; throat with a rather extensive, but incomplete anteriorly and laterally, black spot. Belly very pale blue; lower sides dark gray-blue with few very vague tigroid markings; upper side of limbs brown with dark-gray tigroid markings. Tail brown above, blue-gray below with the ventrolateral pale stripe much reduced and restricted to the anterior third of the tail.

VARIATION: The series of 24 *A. a. pullata* has the following counts: longitudinal ventrals 31-34 (mode 32); rows of transverse ventrals 10 or 12 (3 specimens); fourth-toe scales 64-86 (mean 75.0); femoral pores 23-31 (mean 26.3); fifteenth verticil 24-29 (mean 26.8). The largest male has a snout-vent length of 81 mm., the largest female 81 mm. (see below).

Considering only the specimens from between Matanzas and Cárdenas, and excluding those from San Miguel de los Baños, the paratypes agree very well with the description of the holotype in coloration and pattern. In life, the median and dorsolateral stripes occur in most adults but are never so prominent as they are in subadults and juveniles. The lateral fields are variable but regularly have more tan (rather than red) and the black area is much restricted or even limited to disjunct series of bars or irregular blotches. The black chest and throat — the latter never completely black but having rather a black spot posteriorly — occur only in males. As in the other black-throated subspecies, the size at which the black throat occurs in males is variable in the sample. The smallest (of 13) male with the complete black chest and throat spot has a snout-vent length of 68 mm., the largest 78 mm. All other males with snout-vent length from 66 mm. to 70 mm., have the chest black and an incipiently black spot on the throat, with the exception of one small male, with a snout-vent length of 66 mm., which lacks any black on the throat or chest. In females, the maximal black chest and throat-spot condition is equivalent to the intermediate condition in males — a black chest and an incipient black throat spot. Females in this category range in snout-vent lengths from 62 mm. to 72 mm. Females with snout-vent lengths of 52 mm. to 63 mm. have the chest and throat without black pigment.

The four specimens from San Miguel de los Baños present a different picture. The largest male and the largest female *pullata* (both 81 mm.) are drawn from this small San Miguel sample. Otherwise, the largest *pullata* (from the coastal sample) male measures 78 mm. and the largest female 72 mm. Thus the two San Miguel females (snout-vent lengths 76 and 81 mm.) are larger than all coastal females and the two San Miguel males are large (snout-vent lengths 76 mm. and 81 mm.) and at the upper extreme of the coastal males. The larger San Miguel female also has the throat and chest as black as coastal *pullata* males — a condition not known for coastal females — and the larger San Miguel male also has the throat more extensively black than any coastal *pullata*. Everything considered, I doubt that the San Miguel series is correctly regarded as *A. a. pullata*, and doubtless represents a local interior subspecies. However, absence of an adequate series from interior Matanzas Province precludes further comment.

COMPARISONS: *A. a. pullata* requires comparison only with the other black-throated population thus far described — *A. a. denticola*. In the latter, the throat and chest are wholly black, rather than having only a black spot as in *pullata*. *A. a. denticola* reaches a larger size, and has black lateral fields with red edges, rather than restricted black markings with extensive tan edging in the lateral field region. The two races are separated by the subspecies *procer* and *auberi*. From *auberi*, the race closest to the west (the closest records of *auberi* and *pullata* are 6.6 mi. N.E. Canasí and near Matanzas — about 27 kilometers airline but actually somewhat farther since the Bahía de Matanzas intervenes), *pullata* differs especially in having the black chest and throat spot, whereas *auberi* has the throat orange. *A. a. pullata* also is bordered on the north by the next race from the Península de Hicacos and probably also meets another subspecies from the northeastern corner of Las Villas Province. Comparisons with these races will be made later.

REMARKS: The AMNH type material of *A. a. pullata* (with the exception of the specimens from Cárdenas, which were not taken recently) was collected in grassy areas on the landward side of the extensive beach between Matanzas and the base of the Península de Hicacos, and on the beach itself, in scanty growth of herbs and grasses. The specimens from San Miguel de los Baños were taken in a cut-over *cañaveral* and in grass along its edges. At the latter locality, the lizards were not abundant, whereas along the beaches they were exceptionally common.

Ameiva auberi abducta, new subspecies

HOLOTYPE: AMNH 96331, an adult male, from Punta Hicacos, Matanzas Province, Cuba, taken June 30, 1960, by David C. Leber. Original number 8861.

PARATYPES: AMNH 96332-96360, 8.9 mi. N.E. Varadero, Matanzas Province, Cuba, June 30, 1960, R. F. Klinikowski, D. C. Leber, J. D. Smallwood; IB 133-134, Dupont, Matanzas Province, Cuba, July 6, 1966, O. H. Garrido.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of moderate size (males to 87 mm., females to 68 mm. snout-vent length), moderate number of fourth-toe subdigital scales and femoral pores, high number of scales in the fifteenth caudal verticil; dorsum brownish with persistent pale yellowish tan median and dorsolateral lines in adults, lateral fields usually inconspicuous with black restricted to discrete vertical bars or blotches or absent entirely, lateral field red replaced by brownish; and throats yellowish orange.

DISTRIBUTION: Known only from the distal half of the Península de Hicacos, Matanzas Province, Cuba.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 85 mm., tail 181 mm., tip missing; ventrals in 33 longitudinal and 10 transverse rows; fourth-toe subdigital scales -/36; femoral pores 12 and 13 (total 25); 28 scales in fifteenth caudal verticil. Dorsum dull brownish with median and dorsolateral lines present and yellowish tan; lateral fields obscure and composed of a black reticulum with extensive invasion of brownish, concolor with dorsum. Throat yellowish orange; venter and chest dull bluish. Lower sides dark bluish gray with some vague darker gray tigroid markings. Tail brownish above, dull blue-gray below, ventrolateral caudal stripe obscure. Limbs brownish above with vague darker markings.

VARIATION: The series of 30 *A. a. abducta* has the following counts: longitudinal ventrals 31-34 (mode 32); rows of transverse ventrals 8 (3 specimens) or 10; fourth-toe scales 64-84 (mean 75.2); femoral pores 21-30 (mean 25.4); fifteenth verticil 24-29 (mean 27.6). The largest male has a snout-vent length of 87 mm., and the largest female has a snout-vent length of 68 mm.

The series of paratypes agrees well with the description of color and pattern of the holotype. The persistence of the yellowish tan median and dorsolateral lines is consistent in all adults, although in all cases these lines are not particularly contrasting with the rather drab brownish dorsal ground color. Major variation occurs in the condition of the lateral fields. These may be somewhat more distinct than in the holotype, depending upon the precise shade of the invading tan or brownish pigment and the extent to which it has restricted the back pigment. Some *abducta* lack any sort of black markings in the lateral fields whatsoever, whereas in others the black areas are a less intense gray. Juveniles are not appreciably more brightly colored than adults, although the dorsal lines may be somewhat more apparent.

COMPARISONS: *A. a. abducta* requires comparison with three other subspecies: *paulsoni* (which is also dorsally lined in adulthood), *auberi* (which has an orange throat), and *pullata* (which is geographically

adjacent). All other described races are distinguishable by throat color or dorsal pattern. From *paulsoni, abducta* differs in throat color (yellowish-orange versus cream), in having the dorsal ground color paler (brownish versus reddish brown) with consequent loss of intensity of the dorsal lines (which are bright lemon-yellow in *paulsoni* and yellowish tan in *abducta*). From *auberi*, which has a brightly colored throat, *abducta* differs in having a lineate and paler (brownish versus rusty brown-to-brown) dorsum, and a less brightly colored throat. The ranges of *auberi* and *abducta* are separated by that of *pullata*.

From geographically adjacent *pullata, abducta* differs in having a yellowish orange throat in contrast to a black chest and black-spotted throat. Although both *abducta* and *pullata* are striped dorsally, the striping in *pullata* is much fainter and less consistent an adult feature than in *abducta*.

REMARKS: The Península de Hicacos extends in a northeastern direction from the north coast of Matanzas Province, and is about 20 kilometers long. The outer extreme of the peninsula is rather arid, is covered with extensive scrub and dry woods, and has extensive sandy beaches. Ground lizards were abundant in this latter habitat, which they shared with *Leiocephalus raviceps klinikowskii* Schwartz, and in the scrub itself. The closest records of *abducta* and *pullata* (Dupont and 13 km. N.E. Matanzas) are separated by only 28 kilometers airline, but the latter locality (for *pullata*) is on the Cuban mainland, and much of the basal portion of the Península de Hicacos is presently converted to resorts and hotels and thus not available for extensive collecting. Presumably *abducta* and *pullata* intergrade between these two reported localities. Buide (1966:8), in discussing the peculiarity of distribution of *L. r. klinikowskii*, suggested that this subspecies had evolved on the peninsula when the latter was insular. The differentiation of *A. a. pullata* and *A. a. abducta* may be a comparable situation.

Ameiva auberi gemmea, new subspecies

HOLOTYPE: AMNH 82972, an adult male, from mouth of Río de Sierra Morena, near Playa Ganuza, Las Villas Province, Cuba, taken June 20, 1958, one of a series collected by Albert Schwartz and George R. Zug. Original number 5297.

PARATYPES: AMNH 82970-82971, 82973-82981, same data as holotype; AMNH 82983-82985, 0.5 km. S. Playa de Sierra Moreno, Las Villas Province, Cuba, June 22, 1958, G. R. Zug.

DIAGNOSIS: A Cuban subspecies of A. *auberi* characterized by a combination of large size (males to 105 mm., females to 97 mm. snout-vent length), moderate number of fourth-toe subdigital scales, femoral pores, and scales in the fifteenth caudal verticil; dorsum reddish brown with median and dorsolateral lines yellow-

ish to brown in adults, lateral fields prominent and extensively black with two included rows of discrete brown spots and with scattered bright yellow scales; and throats yellow to orange.

DISTRIBUTION: Known only from the northwestern corner of Las Villas Province, Cuba, near the Las Villas-Matanzas boundary.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 97 mm., tail 182 mm.; ventrals in 33 longitudinal and 10 transverse rows; fourth-toe subdigital scales 32 and 32 (total 64); femoral pores 13 and 14 (total 27); 24 scales in fifteenth caudal verticil. Dorsum reddish brown with median and dorsolateral lines yellowish and fairly prominent; lateral fields black with two longitudinal series of irregularly placed but discrete and more or less round brown dots, the more ventral of the two series additionally dotted with scattered bright yellow scales; lateral fields bounded below by a bold greenish-grayish longitudinal stripe from above the forelimb to the groin. Lower sides gray with a distinct darker-gray reticulum; belly clear grayish centrally, darker grayish blue laterally on two outermost dows of ventrals. Tail brownish above, pale-gray below, with a bold whitish ventrolateral stripe for about half the longth of the tail. Limbs brown above with vague darker reticulations. Throat yellowish, with orange (Pl. 10 E 11) suffusions.

VARIATION: The series of 15 *A. a. gemmea* has the following counts: longitudinal ventrals 31-34 (mode 32); rows of transverse ventrals 10 in all specimens; fourth-toe scales 64-80 (mean 73.8); femoral pores 23-30 (mean 25.9); fifteenth verticil 24-30 (mean 25.9). The largest male has a snout-vent length of 105 mm., the largest female 97 mm.

The reddish brown dorsum with yellowish-to-brown dorsal lines is a common feature of the entire series. The lines in juveniles are yellow to greenish yellow and are even more bold than in the adults. The extensively black lateral fields with their two (or at times, three) rows of discrete, more or less circular, brown spots and additional bright yellow scales are also of regular occurence, at least in adults, and the lateral fields are bordered below by a well-defined greenish or gray lateral stripe, which continues onto the tail as a bold whitish ventrolateral stripe. The throat color varies from flesh (in juveniles) to yellow or orange (Pl. 10 K 2 to Pl. 10 E 11) in adults of both sexes, and the cheeks are usually concolor with the throat. The belly varies from very pale blue (usually) to gray, or even faintly purplish in juveniles.

COMPARISONS: *A. a. gemmea* is unlike any other subspecies of *A. auberi* in having scattered yellow scales in the lateral fields which themselves are distinctive in being extensively black with the double series of discrete brown spots. By these characters *gemmea* may be distinguished from all other subspecies. In throat color *gemmea* resembles *auberi* and *abducta* most closely, but the striped dorsum, details of lateral field coloration and pattern, and dorsal color will distinguish *gemmea* from these two races. The conspicuous lateral fields

of *gemmea* are in strong contrast to those of the geographically close *abducta*.

REMARKS: *A. a. gemmea* is known to occupy only a small area in extreme northwestern Las Villas Province, but its range is almost surely more extensive. At the type locality, the ground lizards were collected in brush and *Acacia* on muddy ground in and about a fresh-water swamp, altogether a rather unusual situation for *Ameiva*. The range of *gemmea* is removed some 58 kilometers airline from the most eastern record for the next adjacent race to the west, *A. a. pullata*, at Cárdenas.

Ameiva auberi extraria, new subspecies

HOLOTYPE: AMNH 82982, an adult male, from Cayo Bahía de Cádiz, Las Villas Province, Cuba, taken June 21, 1958, one of a series collected by Albert Schwartz and George R. Zug. Original number 4380.

PARATYPES: AMNH 96250-96280, same data as holotype.

ASSOCIATED SPECIMENS (all from Las Villas Province, Cuba): IB 41, Cayo Monos de Jutía; IB 64-71, Cayo Lanzanillo; IB 36-40, Cayo Carenero; IB 61-63, Cayo las Tocineras; IB 42-50, Cayo Tío Pepe.

DIAGNOSIS: A Cuban subspecies of *A. a. auberi* characterized by a combination of small size (males to 79 mm., females to 68 mm. snout-vent length), moderate number of fourth-toe subdigital scales, low number of femoral pores, and moderate number of scales in the fifteenth caudal verticil; dorsum yellowish brown to reddish with only a pale-yellow median line which does not extend to the groin but is diffuse or absent entirely posteriorly; lateral fields at best only faintly indicated by a darker brownish streak, and usually absent completely; and throat gray to diffuse dull orange.

DISTRIBUTION: The Archipiélago de Sabana off the northern coast of Las Villas Province, Cuba; known from Cayo Bahía de Cádiz, Cayo Monos de Jutía, Cayo Lanzanillo, Cayo Carenero, Cayo las Tocineras, and Cayo Tío Pepe; specimens from Cayo Carenero tend slightly to be intergradient with the subspecies on Cayuelo de la Vela.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 75 mm., tail 179 mm.; ventrals in 34 longitudinal and 10 transverse rows; subdigital scales 37 and 40 (total 77); femoral pores 11 and 11 (total 22); 29 scales in fifteenth caudal verticil. Dorsum yellowish brown, unlined except for a vague remnant of the median line which is very pale yellow and incomplete posteriorly. Lateral fields absent, their position indicated only by a vague grayish band along each side. Tail brownish above, grayish blue below, and without a ventrolateral pale stripe. Throat grayish orange, belly blue. Cheeks pale yellowish; lower sides dull gray. Upper surfaces of limbs concolor with dorsum and with very vague grayish reticula.

VARIATION: I have grouped together as *A. a. extraria* those specimens of ground lizard from the Archipiélago de Sabana whose throats are gray (in which case the sublabials and infralabials are orange) to dull orange. Lizards from Cayuelo de la Vela (adjacent to Cayo Carenero) I regard as a distinct form, restricted to that cay, because of their hav-

ing black throats and chests. Of the cays inhabited by *extraria*, one (Cayo Bahía de Cádiz) lies near the western end of the chain of islets, near the Matanzas-Las Villas line, whereas the balance of the cays lie about 75 kilometers southeast of Bahía de Cádiz and to the east of the town of La Isabela. The series of 55 *A. a. extraria* has the following counts: longitudinal ventrals 28 - 34 (mode 32); rows of transverse ventrals 8 or 10 (mode 10, but see comments below); fourth-toe scales 68 - 88 (mean 76.3); femoral pores 21 - 27 (mean 23.8); fifteenth verticil 23 - 30 (mean 26.5). The largest male has a snout-vent length of 79 mm. and is from Cayo Monos de Jutía. The largest female has a snout-vent length of 68 mm. and is from Cayo Bahía de Cádiz.

The dorsal color varies from yellowish brown to reddish. The former is the modal adult coloration, the latter that of young subadults and juveniles. The dorsolateral stripes are absent (as are also the lateral fields), and the median dorsal stripe is pale yellow and never complete, disappearing about two-thirds of the way between the neck and the groin. Even the smallest juvenile (snout-vent length 45 mm.) lacks the dorsolateral stripes and the lateral fields. The median dorsal stripe in this juvenile agrees in intensity and extent with that of full adults. In juveniles, the tail is not bright blue but concolor with the dorsum. The throat coloration varies from gray (regularly with orange sublabials and infralabials) to diffuse grayish orange. The differences in throat pigmentation in the topotypical sample may well be correlated with age or sex, but my field notes are not specific in this regard. Sr. Garrido's notes on the IB material indicate that a male from Cayo Monos de Jutía and one from Cayo Tío Pepe had solid orange throats, whereas males from Cayo Carenero, Cayo las Tocineras, and Cayo Lanzanillo have gray throats with orange sublabials and infralabials. Considering the geographic relationships of these cays to each other, it seems preferable to regard all populations as *A. a. extraria* rather than attempt to distinguish two subspecies on the basis of throat color. At least lizards from the various cays present a generally uniform dorsal aspect, although even this, as might be expected, shows some minor variations in intensity of pigmentation. The absence of lateral fields and subdued-to-absent dorsal lineation are common to all samples.

There has been some evolution within the Archipiélago de Sabana, as far as *A. a. extraria* is concerned. This is shown by pertinent scale differences between the several populations regarded as *extraria*. Most noteworthy is the number of transverse ventral rows in the Cayo Tío Pepe sample. Of the nine lizards from this cay, eight have only 8 trans-

verse rows, the ninth having the more orthodox 10. No other Cuban sample studied has such a high incidence of this low count, and in fact no other *extraria* has a count of 8. There is also a distinct tendency for topotypical *extraria* (Cayo Bahía de Cádiz in the west) to have more fourth-toe scales (71 to 88), whereas lizards from the group of eastern cays have slightly lower counts (68 to 77). Despite these peculiarities, I feel that all should at least temporarily be considered *A. a. extraria.* There is such an abundance of cays along this northern Las Villas coast, whose *Ameiva* are as yet unsampled, and the two areas whence specimens are available are so far removed from one another, that to consider all material as *extraria* seems the conservative course at this time.

COMPARISONS: *A. a. extraria* is geographically closest, of the named subspecies, to *A. a. gemmea*, but the two subspecies are very different in pigmentation and pattern. The bold and decorated lateral fields of *gemmea* differ strongly from the virtually non-existent lateral fields of *extraria.* The throat color of *extraria* is darker (gray to dull orange) than that of *gemmea* (yellow to orange), and *gemmea* reaches a much larger size than *extraria* (105 mm. versus 79 mm. in males). The black throats and chests of *denticola* and *pullata* distinguish those races from *extraria*, and the cream throat of *paulsoni* and the yellow throat of *procer* distinguish these subspecies. Those races which have gray-to-orange (although never as dull an orange as *extraria*) throats are *cacuminis, auberi*, and *abducta.* All are somewhat larger than *extraria*, none lacks lateral fields, and none in adults has only a median line without dorsolateral lines. The dorsal pigmentation of *extraria* is paler than that of any subspecies thus far described. In number of femoral pores, *extraria* ranks next to the lowest of all Cuban subspecies.

REMARKS: At the type locality, *A. a. extraria* was quite abundant. The vegetation was arid forest and scrub, with some mangroves along the margins of the cay. In general Cayo Bahía de Cádiz is fairly high and rocky, rather than flat and sandy.

Although Cayo Bahía de Cádiz lies only about 20 kilometers off the coast and on the fringing bank, whose depth between the coast and the cay does not exceed 1.25 fathoms, the striking differences between *gemmea* and *extraria* suggest that either these two subspecies have been long separated from one another or that *extraria* has not been derived directly from the mainland *gemmea* but from a more eastern population. The occurrence of *extraria* on cays off the coast at La Isabela also suggests that neither *gemmea* nor the subspecies on the

adjacent coast and at Sagua la Grande has been the ancestor of *extraria*. Resemblances between *extraria* and subspecies farther to the east are greater than between *extraria* and any of the more western races (including *gemmea, abducta,* and *pullata*). Elaboration of these remarks will follow in a later section.

Ameiva auberi extorris, new subspecies

HOLOTYPE: IB 52, an adult male, from Cayuelo de la Vela, Las Villas Province, Cuba, taken March 11, 1965, one of a series collected by Orlando H. Garrido.

PARATYPES: IB 51, IB 56-57, ASFS V11373-11375, sama data as holotype.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of small size (males to 76 mm. snout-vent length, females unknown), low number of fourth-toe subdigital scales, moderate number of femoral pores, and low number of scales in the fifteenth caudal verticil; dorsum dull brown, completely patternless and without lateral fields; and throat with a black spot and chest black.

DISTRIBUTION: Known only from Cayuelo de la Vela, Archipiélago de Sabana, off the north coast of Las Villas Province, Cuba.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 73 mm., tail 172 mm.; ventrals in 33 longitudinal and 10 transverse rows; fourth-toe subdigital scales -/35; femoral pores 13 and 13 (total 26); 26 scales in fifteenth caudal verticil. Dorsum (as preserved, but not strongly different from color notes) brown, completely without any indication of dorsal lines or lateral fields. Throat gray, with a black posterior spot extending onto the mesoptychium; first three transverse rows of ventrals on chest black. Venter dull blue-gray. Limbs brown, concolor with dorsum. Tail dull gray above, blue-gray (slightly darker than venter) below, without lines.

VARIATION: The series of seven male *A. a. extorris* has the following counts: longitudinal ventrals 31-33 (mode 33); rows of transverse ventrals 10 in all specimens; fourth-toe scales 68-72 (mean 69.5); femoral pores 24-28 (mean 25.3); fifteenth verticil 24-27 (mean 25.4). The largest male has a snout-vent length of 76 mm.; females are unknown.

Little need be said about pattern and color variation in the short series of *extorris*. The series consists exclusively of males with snout-vent lengths ranging between 64 mm. and 76 mm., and the smaller individuals are exactly like the holotype as far as dorsal pattern and coloration are concerned. The entire aspect of the lizards is one of extreme drabness, without markings of any kind.

Males with snout-vent lengths between 68 mm. and 76 mm. have the throat and chest pattern as described for the holotype. The three remaining males with snout-vent lengths between 64 mm. and 69 mm. lack the throat spot but have some black scales on the mesoptychium and chest.

COMPARISONS: *A. a. extorris* requires comparison with the black-throated and black-chested subspecies heretofore named (*denticola, pullata*) and with the geographically adjacent *extraria*. Compared

with the subspecies *denticola* and *pullata, extorris* is much more drab and lacks dorsal lines and lateral fields. Additionally, the entire throat is black in *denticola,* whereas *pullata* resembles *extorris* in having only a black throat spot. As might be surmised, *extorris* most closely resembles its neighbor *extraria,* but *extorris* carries the reduction of dorsal and lateral markings even further, is generally darker than *extraria,* and has the black throat spot and chest which *extraria* lacks. *A. a. extorris* has the next-to-the-lowest mean of number of fourth-toe scales of all the Cuban subspecies, whereas *extraria* ranks ninth in this character.

REMARKS: Although I debated naming the population on Cayuelo de la Vela as a distinct subspecies, the presence of a black throat and chest seems sufficiently distinctive, despite the apparently restricted distribution of the subspecies, to separate these lizards from their relatives on the other cays. Interestingly, a small male (IB 52) *extraria* from Cayo Carenero, the cay closest to de la Vela and separated from it by a narrow channel only two fathoms deep, has a few black scales on the throat, whereas all other Carenero lizards have throats typical of *extraria.* Apparently at least the Carenero lizards still retain the potentiality for black throatedness, and isolation of a population of *extraria* on de la Vela has resulted in the expression of this character on that single island.

Ameiva auberi garridoi, new subspecies

HOLOTYPE: IB 96, an adult male, from Cuatro Bocas, Sagua la Grande, Las Villas Province, Cuba, taken May 2, 1966, one of a series collected by P. Saavedra.

PARATYPES (all from Las Villas Province, Cuba): IB 95, CM 40638-40639, same data as holotype; IB 107-108, IB 110-112, NMC 10066 (3 specimens), CM 40640, same locality as holotype, March 21, 1966, Jorge de la Cruz; ASFS V11376, Finca El Dorado, Sagua la Grande, May, 1966, P. Saavedra; ASFS V11377-11379, IB 116-119, Finca El Dorado, March 9, 1965, O. H. Garrido; IB 79, IB 103, Cayo Boca de Sagua, Isabela de Sagua, May, 1966, P. Saavedra.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of large size (males to 110 mm., females to 70 mm. snout-vent length), high number of fourth-toe subdigital scales, very high number of femoral pores, and high number of scales in the fifteenth caudal verticil; dorsum brown and unlined in adults but with a median and two dorsolateral white lines in subadults and juveniles; lateral fields black, bordered above and below by a marginal row of large brown-to-tan scallops, which in adults tend to limit the black lateral field color into almost a series of vertical lateral bars; and throat lemon-yellow.

DISTRIBUTION: Known only from the region between the city of Sagua la Grande and La Isabela, in northern Las Villas Province, Cuba.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 88 mm., tail 185 mm.; ventrals in 33 longitudinal and 10 transverse rows, subdigital scales 39 and 40 (total 79), femoral pores 12 and

13 (total 25); 27 scales in fifteenth caudal verticil. Dorsum (as preserved) medium brown and unlined; top of head concolor with dorsum. Lateral fields black with two rows of brown scallops, one dorsal and the other ventral, limiting the black lateral field pigment into an irregularly shaped but well-defined lateral figure; lower sides more or less tigroid blue and blue-grey; tail blue-gray above, grayer below, with the white ventrolateral longitudinal line fairly prominent on the basal half of the tail. Throat and mesopytchium clear, bright lemon-yellow. Chest yellow, admixed with blue-gray; venter yellowish medially on about first eighteen transverse rows of ventrals, marbled blue and yellow to cream elsewhere. Limbs blue-gray, vaguely marbled with darker gray, especially on hindlimbs; transverse white thigh line prominent.

VARIATION: The series of 23 *A. a. garridoi* has the following counts: longitudinal ventrals 31-34 (mode 33); rows of transverse ventrals 10 in all specimens; fourth toe scales 68-87 (mean 78.3); femoral pores 25-32 (mean 27.6); fifteenth verticil 26-30 (mean 27.9). The largest male has a snout-vent length of 110 mm., the largest female 70 mm.

Adults resemble the description of the holotype closely. The median and dorsolateral lines are seldom in evidence, and when visible, they are barely discernible in the preserved material. The lateral fields regularly have a dorsal and ventral row of brown scallops, which may ultimately so restrict and limit the black lateral field pigment that the latter becomes a series of vertical bars (ASFS V11376, IB 103) especially anteriorly. The throat is bright lemon-yellow in both sexes, although apparently the throat color of females is somewhat paler than that of males. One male (IB 95, snout-vent length 105 mm., and thus not quite the largest male) has a few black scales on the mesoptychium, and the entire venter has some black pigment dispersed on all the ventrals, although the ventral color is still more blue than black. The largest male (IB 103) shows no evidence of this darkening, nor do any other specimens, regardless of sex or size. The white ventrolateral tail line is at least indicated basally in even the largest specimens.

Females and subadult males and juveniles resemble the adult males in dorsal color and in the configuration of the lateral fields, but there are a median and two dorsolateral white lines. The lateral fields are also delimited below by a pale line.

COMPARISONS: *A. a. garridoi* most closely resembles *A. a. procer* to the west in Pinar del Río Province. Both subspecies have yellow throats and both are quite large, although *procer* exceeds *garridoi* in size (136 mm. versus 110 mm.). Both races have the lateral fields with dorsally and ventrally scalloped edges. Restriction of black lateral field pigment is much more pronounced in *procer* than in *garridoi,* however, and the scallops in *procer* are brick-red rather than brown as in *garridoi. A. a. procer* has a significantly lower mean (71.9) of fourth-toe scales than

does *garridoi* (mean 78.3), which ranks third among the Cuban races. In femoral pores, *garridoi* (mean 27.6) ranks first among the Cuban subspecies, whereas *procer* has a lower mean (26.0) and ranks tenth. The mean of fifteenth caudal verticil scales are high in both subspecies (27.3 and 27.9).

A. a. garridoi differs from the other subspecies in having a lemon-yellow throat (*cacuminis, denticola, paulsoni, auberi, pullata, abducta, gemmea, extraria, extorris*), in having a unicolor and unlined dorsum (*cacuminis, paulsoni, pullata, abducta, gemmea*), and in having lateral fields well expressed (*abducta, extraria, extorris*). The differences between *garridoi* and closely adjacent (but insular rather than mainland) *extraria* and *extorris* are striking in size, coloration, and pattern. The nearest mainland subspecies to the west is *gemmea*, from which *garridoi* differs in many details, not the least of which is the absence of the yellow decorative spots in the lateral fields.

REMARKS: I have not seen living nor freshly collected examples of *A. a. garridoi*. All specimens of this subspecies have been collected by Orlando H. Garrido (for whom the subspecies is named), Jorge de la Cruz, and P. Saavedra. Sr. Garrido (*in litt.*, March 17, 1966), after having collected the first specimens of *garridoi*, noted the distinct characters of this population as he collected material at El Dorado and along the banks of the Río Sagua la Grande. I am very grateful to Sr. Garrido for allowing me to describe this distinctive subspecies and it gives me great pleasure to name it in his honor. Doubtless *A. a. garridoi* will be found to have a wider distribution than the few locality records presently indicate.

Ameiva auberi atrothorax, new subspecies

HOLOTYPE: AMNH 78035, an adult male from Finca Morales, 8 mi. N.W. Trinidad, Las Villas Province, Cuba, taken July 27, 1957, one of a series collected by William H. Gehrmann, Jr., and John R. Feick. Original number 3077.

PARATYPES (all from Las Villas Province, Cuba); AMNH 78034, 78036-78040, same data as holotype; AMNH 78029-78032, Trinidad, July 28, 1957, native collector; AMNH 78033, Trinidad, July 26, 1957, W. H. Gehrmann; AMNH 78044, Trinidad, July 29, 1957, native collector; AMNH 1607, Trinidad, July 30, 1892, F. W. Chapman; AMNH 78045, Finca la Pastora, 2 km. NW Trinidad, July 30, 1957, native collector; IB 100-102, Finca la Pastora, March 8, 1966, O. H. Garrido; AMNH 96361-96368, 8 mi. N.W. Trinidad, July 14, 1960, D. C. Leber, R. F. Klinikowski; USNM 138474-138484, 10 mi. N.W. Trinidad, September 10, 1956, J. D. Hardy; AMNH 78041-78043, Punta Casilda, near Trinidad, July 29, 1957, W. H. Gehrmann, A. Schwartz; ASFS V11380-11382, Casilda, September 1, 1966, T. Naranjo; IB 126-127, ASFS V11383, CM 40641-40642, Cayaguazán, Casilda, March 6, 1966, O. H. Garrido; NMC 10065 (2 specimens), Los Bias-

mones, Casilda, January 20, 1966, T. Naranjo; IB 128-130, Playa de María Aguilar, March, 1965, T. Naranjo.

ASSOCIATED SPECIMENS (all from Las Villas Province, Cuba): USNM 136096, UMMZ 65323 (2 specimens), MCZ 22720, MCZ 12363-12364, MCZ 32675, MCZ 22278, MCZ 84918-84919, Soledad; AMNH 82986 (2 specimens), 2.9 mi. S.E. Soledad; AMNH 78072, Guajimico, 16 mi. S.E. Soledad; AMNH 78071, 5 km. S.E. Paso Caballo; MCZ 22721, western edge, Sierra de Trinidad.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of large size (males to 126 mm., females to 93 mm. snout-vent length), high number of fourth-toe subdigital scales and femoral pores, and very high number of scales in fifteenth caudal verticil; dorsum tan, either unicolor or with moderately prominent greenish to yellow median and dorsolateral lines, lateral fields with extensive tan markings (concolor with dorsum) and black restricted to a series of irregular blotches or vermiculations; chest black, and throat with a posterior black patch.

DISTRIBUTION: South-central Las Villas Province, Cuba, from Paso Caballo and Soledad on the west to Trinidad and Casilda on the east.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts; snout-vent length 106 mm., tail 256 mm.; ventrals in 33 longitudinal and 10 transverse rows; fourth-toe subdigital scales 42 and 40 (total 82); femoral pores 15 and 15 (total 30); 31 scales in the fifteenth caudal verticil. Dorsum tan, without a median line but with dorsolateral lines greenish and fairly prominent. Lateral fields obscure, consisting of an irregular black reticulum encroached upon by extensive tan markings, concolor with dorsum. Lower sides mottled greenish yellow. Venter bright blue (Pl. 33 K 4) laterally and pale blue centrally. Limbs tan dorsally, with some vague grayish markings; hindlimbs flecked pale blue (Pl. 33 G 5). Tail tan above, grayish blue below; pale ventrolateral caudal stripe obscure. Chest black (including first 12 transverse rows of ventrals); throat with a large black patch or blotch, continuous across mesoptychium with black chest. Face suffused with reddish, most prominent on lips, around tympanic opening, and sides of neck.

VARIATION: The series of 65 *A. a. atrothorax* has the following counts: longitudinal ventrals 31-35 (mode 34); rows of transverse ventrals 10, 11 (1 specimen), or 12 (4 specimens); fourth-toe scales 72-91 (mean 79.0); femoral pores 21-32 (mean 26.8); fifteenth verticil 25-33 (mean 29.5). The largest male has a snout-vent length of 126 mm., the largest female 93 mm.

A. a. atrothorax is a somewhat variable race as far as dorsal pattern is concerned. The dorsal ground color is always tan. The median and dorsolateral pale lines may be expressed or not in full adults, and their color is variable, from greenish (in the Trinidad region) to yellow (Paso Caballo). The lateral fields are likewise variable, although the black reticulum and much invasion of tan pigment into the lateral field area is the modal condition. At times the black pigment forms a sinuous and rather irregular line, or a series of rather vertically oriented short bars or spots. Only in juveniles is the lateral field extensively black. In adults from near Soledad the lateral fields are more prominent than

they are in Trinidad specimens. The lower sides have been regularly recorded in life as greenish yellow or bluish green.

The status of the black chest and throat pigmentation in both sexes may be summarized as follows. Thirty males (snout-vent length 65 mm. to 126 mm.) and thirty females (snout-vent lengths 55 mm. to 93 mm.) were separated into four categories: (1) black chest and black throat patch fully developed; (2) black chest fully developed and small black throat patch; (3) black chest fully developed and only faint indication of black throat patch; (4) no black on chest or throat. Thirteen males (snout-vent lengths 72 mm. to 126 mm., and thus including the largest male) fall in the first category and thus have the complete complement of dark pigment. Ten males (snout-vent lengths 75 mm. to 108 mm.) have the chest black and the throat patch partially developed. Four males (snout-vent lengths 70 mm. to 90 mm.) fall into category 3, and three males (snout-vent lengths 65 mm. to 82 mm.) lack any black pigment and fall into category 4. In summary, almost all males (one exception, snout-vent length 82 mm.) above 71 mm. have at least the chest black; the degree of development of the throat patch is variable but it is usually well expressed at snout-vent lengths above about 90 mm. Only one female (snout-vent length 60 mm.) falls in category 1, and only four females (snout-vent lengths 61 mm. to 93 mm.) fall into category 2. Eight females (snout-vent lengths 63 mm. to 87 mm.) are regarded as being in category 3, and 17 females (snout-vent lengths 55 mm. to 80 mm.) lack any black pigment and are in category 4. In summary, development of black chest and throat in females seldom reaches the extreme it does in males. Females in excess of 79 mm. are fairly consistent in having some black chest and throat pigment, whereas females below 68 mm. usually lack pigment on either chest or throat. The significance of these variations in each sex is no more open to solution here than in the previously discussed black-throated and black-chested subspecies.

Although the juvenile dorsal color is tan as it is in adults, juveniles are purplish ventrally. This ventral coloration may persist into some subadult females as dull pink.

COMPARISONS: In having a black chest and black throat spot (in contrast to an all-black throat), *A. a. atrothorax* is like *A. a. pullata* and *A. a. extorris*. The southern Las Villas subspecies reaches a much larger size (126 mm. in male *atrothorax*, 81 mm. in male *pullata*, 76 mm. in male *extorris*) than the two similar subspecies, has a tan dorsum (brown in *pullata*), and has the lateral fields present and prominent

(absent in *extorris*). The very high mean number of scales in the fifteenth caudal verticil in *atrothorax* (29.5) contrasts with the much lower means in *pullata* (26.8) and *extorris* (25.4). Similar mean differences in fourth-toe scales (79.0 in *atrothorax*, 75.0 in *pullata*, 69.5 in *extorris*) are significant. The races *atrothorax* and *pullata* resemble each other in dorsal pattern (either unicolor or with faint longitudinal lines), although the lines are usually greenish in *atrothorax* and yellow in *pullata*.

A. a. atrothorax differs from all other subspecies except *denticola*, in having a black chest and a black throat patch. *A. a. atrothorax* differs from *denticola* in having a black throat patch rather than the throat entirely black.

REMARKS: In my experience, *Ameiva* is not especially common in the vicinity of Trinidad. Specimens were collected on the outskirts of the city along stone walls in short grass, and at Punta Casilda only a very few were seen along the boulder- strewn beach. The series from the type locality was taken in xeric scrub woods. The substrate was limestone outcroppings and rocks, imbedded in red earth (see Schwartz, 1959d:15 for description). Several sandy scrub areas along the coast between Trinidad and Cienfuegos were visited, but despite apparently suitable habitat, no *Ameiva* were observed. The fact that only a single specimen was collected in two days at Paso Caballo is significant.

Hardy (1956:323) reported the occurrence of *A. auberi* on Cayo Macho de Tierra, about 10 miles southeast of the town of Casilda. No specimens were collected and the racial status of this population remains in doubt. These lizards may be assignable to *atrothorax* or may represent an endemic race on this small offshore islet.

The known range of *A. a atrothorax* is removed about 120 kilometers from that of the closest described subspecies, *A. a. garridoi*, in northern Las Villas Province. Although much of the area between these two races seems suitable for *A. auberi*, no specimens are known from this intervening region. In fact, no *Ameiva* have been collected along the south coast of Cuba between *atrothorax* and Cabo Cruz to the east, and, with the exception of the population next to be described at Juraguá on the southern Las Villas coast, there are no *Ameiva* known to the west until one reaches Dayaniguas in Pinar del Río Province. Thus *A. a. atrothorax* and the Juraguá subspecies stand alone on the coast of central southern Cuba.

Ameiva auberi peradusta, new subspecies

HOLOTYPE: IB 85, an adult male, from Juraguá, Las Villas Province, Cuba, taken May 15, 1966, one of a series collected for Orlando H. Garrido.

PARATYPES: IB 86-90, CM 40643-40646, same data as holotype; ASFS V11166-V11170, NMC 9584 (4 specimens), MSB 374, 376-378, 380-381, 383-384, 387, same locality as holotype, April 27, 1965, M. S. Buide.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of large size (males to 105 mm., females to 76 mm. snout-vent length), very high number of fourth-toe subdigital scales, high number of femoral pores and scales in fifteenth caudal verticil; dorsum grayish black in adults, without longitudinal lines, lateral fields terra cotta, with or without (usually) some included irregular markings or blotches; sides of head, neck, all of throat, under sides of both forelimbs and hindlimbs, and almost all of venter, rich, lustrous black.

DISTRIBUTION: Known only from the type locality on the west side of the Bahía de Cienfuegos, Las Villas Province, Cuba.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 105 mm., tail 210 mm.; ventrals in 33 longitudinal and 10 transverse rows; fourth-toe subdigital scales 44 and 43 (total 87); femoral pores 13 and 13 (total 26); 29 scales in the fifteenth caudal verticil. Dorsum dull grayish black, top of head dark grayish brown; no dorsal or dorsolateral lines. Lateral fields terra cotta in life with a few scattered and irregularly shaped black spots or flecks within the terra cotta band. Sides of head and neck, all of throat, under side of forelimbs and all of venter rich, lustrous black; under side of hindlimbs dark gray. Infralabials and sublabials blackish gray; snout reddish. Forelimbs darker than hindlimbs above, the former concolor with the dorsum, the latter paler brownish gray with some scattered flecking. Lower sides blue-black, with some isolated blue flecks on the more lateral black rows of ventrals. Tail gray-brown above, blue-gray below; ventrolateral pale caudal stripe indistinct on basal third of tail, absent on distal two-thirds.

VARIATION: The series of 28 *A. a. peradusta* has the following counts: longitudinal ventrals 32-36 (mode 33); rows of transverse ventrals 10 or 11 (1 specimen); fourth-toe scales 70-87 (mean 79.9); femoral pores 23-33 (mean 27.2); fifteenth verticil 26-32 (mean 28.9). The largest male is the holotype with a snout-vent length of 105 mm.; the largest female has a snout-vent length of 76 mm.

The series of *A. a. peradusta* is remarkably consistent in all details of color and pattern. The lateral fields may be less red than those described for the holotype, and in many preserved specimens the lateral fields are no longer evident. Such individuals lack any black flecks or blotches in the lateral field areas, and the dorsum and sides are unicolor grayish black to brownish gray. The black throat, venter, cheeks, and neck are constant features of males, regardless of size. Even the smallest male available (CM 40644, snout-vent length 75 mm.) is equally as black as the largest males. There are only three females. One of these (CM 40646, snout-vent length 71 mm.) has the throat and chest solid black, and there is incipient black and gray smudging over the rosy venter

and on the underside of the forelimbs. This female is dark brown dorsally with three greenish, almost fluorescent, lines. The lateral fields are unmarked brown, almost terra cotta, and the hindlimbs are dotted with black. A second female (CM 40645, snout-vent length 72 mm.) resembles males dorsally, lacks lateral fields, and has the black restricted to the throat and chest, with some black suffusion on the balance of the venter. In both sexes the pale ventrolateral caudal stripe and the transverse thigh line are inconspicuous.

COMPARISONS: *A. a. peradusta* is so very distinctive that it requires comparison with no other Cuban subspecies. The black cheeks, neck, throat, and venter distinguish it from all other known populations of *A. auberi* in Cuba. Its closest geographic ally is *atrothorax*, from which *peradusta* can be distinguished by the characters that separate it from all other subspecies.

REMARKS: I am indebted to Sr. Garrido for his excellent notes on *A. a. peradusta* and to Sr. Buide for the gift of specimens in his private collection. Both these men were most impressed with the differences between *peradusta* and other *Ameiva* they had collected, and certainly *peradusta* is one of the most distinctive of all the subspecies of *A. auberi*, both Cuban and Bahamian.

Juraguá lies on the west side of Bahía de Cienfuegos. Although the mouth of the bay is very narrow, it effectively separates *peradusta* from *atrothorax*, which occurs in the vicinity of Paso Caballo on the east side of the mouth of the bay. Almost certainly, *peradusta* is a direct derivative of *atrothorax*, a derivative that has been isolated on the west side of the bay. As noted in the discussion of *atrothorax*, there are no *Ameiva* known to the west of *peradusta* until the occurrence of *procer* at Dayaniguas in Pinar del Río Province. Possibly *A. a. peradusta* will be found to be widespread along the southern coast between the Bahía de Cienfuegos and the Bahía de Cochinos. At this time there are no specimens from this entire southern area. Other than the adjacent *atrothorax*, the nearest known population to *peradusta* is *gemmea*, some 110 kilometers to the north along the northern Las Villas coast.

Ameiva auberi llanensis, new subspecies

HOLOTYPE: MCZ 59321, an adult male, from just south of the west end of Sierra de Cubitas, Camagüey Province, Cuba, taken August 21, 1959, by Ramón Molina, Ernest E. Williams, and Rodolfo Ruibal.

PARATYPES (all from Camagüey Province, Cuba): AMNH 78069, 2 km. S.E. Banao, August 15, 1957, J. R. Feick; AMNH 78070, 2 km. S.E. Banao, August 18, 1957, J. R. Feick; AMNH 96409, 0.1 mi. S.E. Banao, August 3, 1960, D. C.

Leber; AMNH 96406-96408, 2.7 mi. S.E. Banao, August 3, 1960, R. F. Klinikowski, D. C. Leber; AMNH 96404-96405, 8.5 mi. S.E. Banao, August 3, 1960, D. C. Leber; MCZ 57934-57935, halfway between Camagüey and Banao, July 16, 1957, R. Molina and R. Ruibal; MCZ 7277, 84917, Camagüey, 1908, T. Barbour.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of moderate size (males to 90 mm., females to 78 mm. snout-vent length), moderate number of fourth-toe subdigital scales, very low number of femoral pores, and high number of scales in fifteenth caudal verticil; dorsum brownish with fairly prominent faintly yellow median and dorsolateral lines, the dorsal fields (between the median and dorsolateral line on each side) blotched or marbled with black (especially posteriorly), lateral fields black with heavy brown spotting; and throat pale orange.

DISTRIBUTION: The serpentine savannas from the western end of the Sierra de Cubitas south to the vicinity of the city of Camagüey, Camagüey Province, Cuba.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 90 mm., tail 211 mm.; ventrals in 33 longitudinal and 10 transverse rows; fourth-toe subdigital scales 42 and 39 (total 81); femoral pores 12 and 13 (total 25); 28 scales in the fifteenth caudal verticil. Dorsum brown with pale median and dorsolateral stripes evident but only fairly prominent; dorsal fields between median and dorsolateral stripes marked (especially on posterior half of trunk, but visible anteriorly as well) with fine filigreed dusky gray marblings. Lateral fields broad and black, the black much restricted by about three longitudinal series of brown, subcircular spots, and bounded below by a prominent pale lateral line. Lower sides blue, marbled with dark gray. Venter pale blue; throat pale (pale orange in life?). Tail brown above, pale grayish blue below; pale ventrolateral caudal stripes well developed on basal third of tail.

VARIATION: The series of 13 *A. a. llanensis* has the following counts: longitudinal ventrals 31-34 (mode 34); rows of transverse ventrals 10; fourth-toe scales 68-81 (mean 73.5); femoral pores 21-26 (mean 23.8); fifteenth verticil 25-30 (mean 27.7). The largest male has a snout-vent length of 90 mm., the largest female 78 mm.

The most distinctive dorsal feature of *A. a. llanensis* is the filigreed to boldly marbled dorsal fields. This is a common attribute of all specimens, regardless of size, but it is variable in intensity. Two old specimens from the city of Camagüey (MCZ 7277 and 84917) show the dorsal markings most vividly, but perhaps this is due to the length of time these lizards have been in preservative, with consequent lightening of the dorsal brown pigments, thereby rendering the dark markings more apparent. The lateral fields are always bold and very heavily spotted with two or three series of large ovoid or subcircular brown spots, which at times fuse with one another. In fresh specimens, the dorsal coloration is brownish. The median and dorsolateral lines are faint yellow and persist in adults. The venter is a very pale blue (almost gray) centrally, and the lower sides and lateral-most rows of ventrals are darker blue to greenish. The throat is pale orange (Pl. 11

B 8) grading to pale yellow on the sides of the throat and on the sublabials. The longitudinal stripe below the lateral fields is clear greenish in life.

Although there are no juvenile specimens, small subadults (snout-vent lengths 61 to 65 mm., both sexes represented) have the blotched dorsal fields as adults do.

COMPARISONS: The blotched dorsal fields separate *A. a. llanensis* from all other subspecies of *A. auberi*, including the orange-throated races *auberi, abducta, gemmea* and *extraria*. In lateral field pigmentation, *llanensis* most closely resembles *gemmea*, although these two subspecies are not close geographically.

REMARKS: In the serpentine savannas of Camagüey Province, *Ameiva* appears to be distinctly uncommon. Only eight specimens were secured by myself and parties in two lengthy visits to this region. All were taken on sandy soil or the gravelly and rocky hillocks that dot the area, and that are frequented as well by *Leiocephalus stictigaster ophiplacodes* Schwartz. The vegetation where the *Ameiva* were collected was regularly short, sparse grass.

The known range of *A. a. llanensis* encompasses only a small portion of the serpentine savannas that extend from central Camagüey to northwestern Oriente and are bounded on the north by the Sierra de Cubitas. *A. a. llanensis* is well removed from *Ameiva* to the west, with *atrothorax* the closest known subspecies at a distance of about 200 kilometers airline. Despite collecting at several stations between those two regions, no *Ameiva* has been observed.

ADDITIONAL SPECIMENS

It is appropriate here to mention ten specimens from Las Villas and Camagüey provinces which are not racially assigned at this time. These include one subadult female (AMNH 6516) from the Sierra de Jatibonico near the Camagüey-Las Villas province line, and a series of nine specimens (AMNH 96410-96418) from 11.9 mi. N.W. Banao, Camagüey Province. The first specimen is long preserved, but it is distinct from the two closest subspecies near the north coast — *garridoi* on the west and *llanensis* on the east — although neither of these is known to occur close to the Sierra de Jatibonico. The locality is nearer geographically to the range of *atrothorax* on the south, but the lizard does not appear to represent that subspecies. I leave it temporarily unassigned subspecifically.

The series from northwest of Banao was collected by myself and party in 1960. This locality is north of the Sierra de Cubitas (in which

range *Ameiva* is not known to occur), and the lizards were taken along a road through mesic lowland forest — a quite different habitat from that occupied by *llanensis* to the south of the Cubitas. My color notes are not adequate to diagnose these specimens; they do differ from all other Las Villas and Camagüey races (except *gemmea* and *garridoi*) in having pale yellow throats. The specimens resemble *gemmea* in lateral field and dorsal patterns but seem to lack the scattered yellow scales in the lateral fields, which is so distinctive a feature in *gemmea*. Since *gemmea* is separated from these Camagüey specimens by the interposed range of *garridoi*, it seems unlikely that they represent the former subspecies. They might also be assignable to *garridoi*, but considering the distance separating them from *garridoi* (about 250 kilometers), I doubt that they are correctly to be considered *garridoi* either. Additional material from this region will be necessary before the status of this population can be ascertained.

Ameiva auberi sublesta, new subspecies

HOLOTYPE: AMNH 96393, an adult male, from Playa Bonita, east end, Cayo Sabinal, Camagüey Province, Cuba, taken July 31, 1960, one of a series collected by Ronald F. Klinikowski, David C. Leber, and James D. Smallwood. Original number 9585.

PARATYPES: AMNH 96392, 96394-96403, same data as holotype.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of small size (males to 81 mm., females to 67 mm. snout-vent length) high number of fourth-toe subdigital scales, femoral pores, and scales in the fifteenth caudal verticil; dorsum tannish gray with gray-to-cream median line which expands and fades posteriorly; dorsolateral lines obscure to absent, lateral fields with black restricted to isolated small blotches or obsolescent grayish vertical bars because of intrusion of dark-brown edges of lateral fields; and throat brick red.

DISTRIBUTION: Known only from Cayo Sabinal off the northern coast of Camagüey Province, Cuba.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 81 mm., tail broken and partially regenerated; ventrals in 33 longitudinal and 10 transverse rows; fourth-toe subdigital scales 39 and 41 (total 80); femoral pores 12 and 13 (total 25); scales in fifteenth caudal verticil uncountable. Dorsum dull tannish gray without dorsolateral light lines; median dorsal line gray, expanding on midback and fading out posteriorly. Tail gray above, dull bluish gray below; ventrolateral pale stripe obscure. Lateral fields obscure, reduced to a few black or dark-gray flecks in an obsolescent brown stripe, not set off from either dorsal or lateral pigmentation by pale lines. Limbs dull brownish with very vague grayish markings. Belly dull bluish; throat brick red.

VARIATION: The series of 12 *A. a. sublesta* has the following counts: longitudinal ventrals 32-34 (mode 33); rows of transverse ventrals 8 (1 specimen)-10; fourth-toe scales 69-84 (mean 77.6); femoral pores 25-28 (mean 26.3); fifteenth verti-

cil 26-30 (mean 28.0). The largest male has a snout-vent length of 81 mm., the largest female 67 mm.

The tannish gray dorsal coloration and gray-to-cream expanding and fading median dorsal line are common features of the series. In some specimens the lateral fields are more solidly black than in the holotype and have about two longitudinal series of subcircular brown dots. In other individuals of the same size these dots are coalesced and restrict the black pigment to spots of flecks on an otherwise brown ground. At best, the dorsolateral lines are faint and lack the distinctness of the median line; thus the lateral fields are not outlined in pale above. Both sexes have the throats brick red; the throats of males are more deeply pigmented (Pl. 3 I 12) than are those of females (Pl. 3 A 10). There seems to be no ontogenetic change in dorsal pattern and color, since a juvenile female with a snout-vent length of 45 mm. is comparable in these features to the adults.

COMPARISONS: Of the described races, *A. a. sublesta* most closely resembles the more western *A. a. extraria*. The brick-red throat of *sublesta* (the only subspecies with this feature) differs from the dull orange or gray throat of *extraria*, and the dorsal ground color of *extraria* is darker (yellowish brown to reddish) than the tannish gray of *sublesta*. The median dorsal line that expands and fades out posteriorly is characteristic of a complement of eastern subspecies of *A. auberi* (and occurs as well in *extraria*). It is obvious that the relationships of *sublesta* are with the eastern Camagüey-Oriente subspecies rather than with races on the mainland to the west. Comparisons with these more eastern subspecies will be made below.

REMARKS: As just noted, *A. a. sublesta* is doubtless derived from the eastern Camagüey subspecies about to be described. The physical relationships of Cayo Sabinal to the mainland and the balance of the northern Camagüey *cayeria* have been discussed elsewhere (Schwartz, 1964a:216). The lizards were moderately abundant on Cayo Sabinal, and were collected in coastal scrub, along the beach, and on the mud in and about coastal mangroves. At most localities they were accompanied by *Leiocephalus stictigaster parasphex* Schwartz.

Ameiva auberi citra, new subspecies

HOLOTYPE: AMNH 96375, an adult male, from 2 mi. W. Playa Santa Lucía, Camagüey Province, Cuba, taken July 27, 1960, one of a series collected by Ronald F. Klinikowski and James D. Smallwood. Original number 9532.

PARATYPES (all from Camagüey Province, Cuba): AMNH 96374, 96376-96386, same data as holotype; AMNH 96387-96391, 3 mi. W. Playa Santa Lucía, July 27, 1960, R. F. Klinikowski, J. D. Smallwood; AMNH 83749-83754, Playa Santa Lucía, June 29, 1959, R. F. Klinikowski, B. L. Smith; AMNH 83755-83760, Playa Santa Lucía, June 30, 1959, R. F. Klinikowski, B. L. Smith; AMNH 96369-96373, 1 mi. E. Playa Santa Lucía, July 26, 1960, D. C. Leber, A. Schwartz.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of moderate size (males to 93 mm., females to 72 mm. snout-vent length), high number of fourth-toe subdigital scales, low number of femoral pores, and moderate number of scales in the fifteenth caudal verticil; dorsum dull tan, median dorsal stripe lemon-yellow to pale tan, expanding and fading posteriorly, dorsolateral lines absent or restricted to anterior half of trunk in adults, lateral fields variable from black with two or three longitudinal series of brick-red spots to completely obsolete, even in juveniles, and throat gray to faintly orange.

DISTRIBUTION: Known only from the vicinity of Playa Santa Lucía, on the north coast of Camagüey Province near the Oriente border, Cuba.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 92 mm., tail 190 mm.; ventrals in 33 longitudinal and 10 transverse rows; fourth-toe subdigital scales 39 and 38 (total 77); femoral pores 12 and 12 (total 24); 27 scales in fifteenth caudal verticil. Dorsum dull tan with a pale-tan median dorsal line which expands and fades out posteriorly; dorsolateral lines faint, tan, and restricted to anterior half of body. Tail dull grayish tan dorsally, bluish ventrally; ventrolateral pale caudal stripe moderately prominent on basal half of tail. Lateral fields black with a series of two brick-red spots along the upper and lower margins, the spots restricting the interior black to a series of irregular markings; lateral fields bordered below by a gray longitudinal stripe. Lower sides gray with a few darker vermiculations. Limbs dull tan above with a few vague darker marblings. Throat grayish orange; venter bluish.

VARIATION: The series of 31 *A. a. citra* has the following counts: longitudinal ventrals 31-35 (mode 32 or 33); rows of transverse ventrals 8 (2 specimens) — 10; fourth-toe scales 67-89 (mean 77.2); femoral pores 20-29 (mean 24.3); fifteenth verticil 24-29 (mean 25.8). The largest male has a snout-vent length of 92 mm., the largest female 72 mm.

The most variable feature of *A. a. citra* is the condition of the lateral fields. In some individuals the lateral field is a solid black band with a minimum of brick-red "frosting" scales along its edges. At the other extreme is the condition described for the holotype. Some specimens also seem to lack the lateral fields entirely except for a reddish-brick-to-brownish area along each side. None of these conditions is correlated with size, and all occur in adults, subadults, and juveniles. The throats vary between gray and orange (Pl. 9 B 7) and are never bright.

Although my notes do not so indicate, presumably the brighter color is that of the males. The median dorsal stripe is pale tan to lemon-yellow, with the brighter shades in subadults. The belly varies from purplish in juveniles to bluish in adults and is not bright.

COMPARISONS: *A. a. citra,* in having a gray-to-orange throat, is easily differentiated from those subspecies with throats that are black or have a black spot (*denticola, pullata, extorris, atrothorax*), and those that have the throat colored other than orange (*procer, paulsoni, abducta, garridoi, sublesta*). Of these, *sublesta* is the closest geographically. From all described subspecies except *extraria* and *sublesta, citra* differs in having the median dorsal line expanded and disappearing posteriorly. The median stripe is pale tan to lemon-yellow in *citra,* gray to cream in *sublesta,* and pale yellow in *extraria.* The dorsal ground color is yellowish brown to reddish in *extraria,* tannish gray in *sublesta,* and dull tan in *citra.*

REMARKS: *A. a. citra* is obviously closely allied to its neighbor on Cayo Sabinal, *A. a. sublesta;* the ranges of the two are separated only by a narrow channel. As pointed out previously, *sublesta* and *citra* show a style of dorsal pattern that occurs from northeastern Camagüey eastward along much of the Oriente coast.

At and about Playa Santa Lucía, *A. a. citra* was moderately abundant, occurring in coastal scrub, along the mangrove border, in small mangroves on a rocky substrate, along the beaches (where the lizards were distinctly less common than in habitats behind the beach), and the arid woods near Punta Practicos where they were taken in *Eugenia* thickets.

Although the range of *A. a. citra* is apparently circumscribed, the race is presumably distributed farther to the east, at least along the Oriente coast. The Oriente style of dorsum does not occur on the mainland to the west of Playa Santa Lucía, since the specimens from the north coast of Camagüey north of the Sierra de Cubitas already noted possess longitudinally lined dorsa without suppression of the dorsolateral lines characteristic of the more central and western subspecies. The closest named population to the west of *citra* is *llanensis* (removed 95 kilometers airline), and the unnamed population north of the Sierra de Cubitas lies at about the same distance from *citra.*

Despite two long visits to Playa Santa Lucía and extensive collecting to the south of that resort, no *Ameiva* were seen in what appeared to be suitable habitats. Much of the country to the south of Playa Santa Lucía is cut-over xeric forest, a habitat these lizards often occupy.

Ameiva auberi granti, new subspecies

HOLOTYPE: AMNH 83784, an adult male, from Baracoa, east side, Bahía de Miel, Oriente Province, Cuba, taken August 8, 1959, one of a series collected by Filo Hernández and Ronald F. Klinikowski. Original number 8178.

PARATYPES (all from Oriente Province, Cuba): AMNH 83785-83788, same data as holotype; USNM 139779-139783, Banes, May, 1957, C. Grant; AMNH 83790, Baracoa, August 11, 1959, native collector; USNM 29849, Baracoa, February 2, 1902, W. Palmer; MCZ 11896-11901, Baracoa, September, 1915, V. J. Rodríguez; MCZ 11206-11207, Baracoa, date unknown, V. J. Rodríguez; AMNH 83789, 9 km. W., 1 km. S. Baracoa, bank of Río Bay, August 10, 1959, B. L. Smith; IB 1243-1245, La Poa, road to La Florida, Sabanilla, Baracoa (not mapped), March 18, 1967, O. H. Garrido; AMNH 83935, Bahía de Taco, December 21, 1959, A. Schwartz; AMNH 83946-83950, 5 mi. N.W. Bahía de Taco, December 25, 1959, P. F. Pepe and J. R. Talada; USNM 80412, Río Moa, Puerto Moa, March 8, 1930, L. H. Parish and W. Perrygo; MCZ 59322-59323, ca. 9 km. S.E. Moa, July 21, 1959, R. Molina and R. Ruibal; UMMZ 98018, Preston, date unknown, C. Clark; UIMNH 64448-64462, 64464, Banes, April, 1956, C. Grant.

ASSOCIATED SPECIMENS (all from Oriente Province, Cuba): USNM 80415, IB 17, IB 19-30, ASFS V11384-V11388, Gibara.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of moderate size (males to 93 mm., females to 82 mm. snout-vent length), moderate number of fourth-toe scales and femoral pores, and low number of scales in the fifteenth caudal verticil; dorsum reddish tan in adults, dark brown in subadults and juveniles, median dorsal stripe yellow, expanding and fading posteriorly and continuing onto tail as a distinctly defined gray median caudal zone, dorsolateral lines yellow and often irregular or fragmented, outlining lateral fields which are extensively black with small red scallops or isolated dots, and chest and throat black (see, however, discussion).

DISTRIBUTION: The north coast of Oriente Province, Cuba, from Banes (and possibly as far west as Gibara) on the west to the vicinity of Baracoa on the east.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 93 mm., tail 166 mm., incomplete; ventrals in 32 longitudinal and 10 transverse rows; fourth-toe subdigital scales 36/-; femoral pores 13 and 14 (total 27); 26 scales in fifteenth caudal verticil. Dorsum reddish tan with paler tan median line which expands and fades posteriorly and becomes a sharply distinct gray dorsal band (about four scales wide) on the upper surface of the tail; sides of tail black, admixed with tan scales basally, the black fading to darker gray distally; caudal ventrolateral pale stripe conspicuous basally but becoming dim distally. Lateral fields extensively black, bounded above by a rather irregular or slightly sinuous tan line, the fields with an upper and lower series of red spots (at times joined to the lateral green stripe below the lateral fields). Sides greenish and heavily tigroid with dark gray. Limbs reddish tan above with rather heavy gray vermiculations. Throat and chest (to about level of fourteenth transverse row of ventrals) black; venter bluish gray, slightly brighter on under side of tail.

VARIATION: The series of 57 *A. a. granti* (including material from Gibara) has the following counts: longitudinal ventrals 31-34 (mode 32); rows of transverse

ventrals 9 (1 specimen)-10; fourth-toe scales 63-92 (mean 75.9); femoral pores 21-31 (mean 25.7); fifteenth verticil 22-29 (mean 25.1). The largest male has a snout-vent length of 93 mm., the largest female of 82 mm.

The material from Gibara, here assigned tentatively to *granti*, will be discussed separately below. Except for the Gibara specimens, *A. a. granti* is fairly constant in all chromatic characters throughout its relatively long range. The dark dorsum with yellow (to tan in subadults and juveniles) expanding and fading middorsal line, which in turn gives rise to the sharply delineated gray upper surface of the tail, bounded laterally by the black sides of the tail, is a common feature. The ventrolateral white caudal stripe is also prominent and serves to delimit sharply the black lateral faces of the tail below. As usual, the lateral fields are somewhat variable, but they usually have irregular edges and some sort of scalloping or spotting. Very rarely are they solid black as in some southern Oriente populations. The tail is blue in young adults and juveniles.

Ameiva a. granti shows the by-now rather familiar black chest of the black-throated races of *A. auberi;* however, except for the Gibara specimens, the situation in male *granti* is diagrammatic. All (26) males with snout-vent lengths above 67 mm. have the throat and chest solid black, and at times the black pigment extends far posteriorly onto the belly. Only a single subadult male (60 mm. snout-vent length) has the chest black and a dark gray (rather than black) throat. The situation in females is not so clear. The females fall into three categories. Only two specimens have a completely black throat and chest (category 1). These have snout-vent lengths of 58 mm. and 77 mm. Eight females have a black chest and gray throat (category 2). These range in snout-vent length from 55 mm. to 82 mm. and include the largest female. Seven females that lack any black pigment on either chest or throat (category 3) have snout-vent lengths of 58 mm. to 72 mm. Thus the females that lack black pigment are bracketed on both sides by females with solid black or gray areas. The occurrence of solid black chests and throats in two females is unusual. Both of these were taken in December. The 58 mm. female without black pigment was collected in April. April-taken females with gray throats and black chests include two specimens with snout-vent lengths of 64 mm. and 72 mm.

Although I include the Gibara series with *A. a. granti*, I do so with some misgivings. I have not seen Gibara lizards in life, but the excellent lot, collected by Sr. Garrido, from that area is fresh. Sr. Garrido has also supplied me with a color diagram and color slides of these Gibara lizards. Dorsally, these lizards do not violate my concept of *granti* except

that the median dorsal stripe is very pale tan, almost cream, and the dorsolateral pale lines are not fragmented. The lateral fields agree in detail with *granti* from farther east. My hesitancy in regarding them (with complete certainty) as *granti* arises from the throat condition: of the series of 18 fresh Gibara lizards, all but one have pale orange throats, whereas that exceptional lizard (a male with a snout-vent length of 67 mm), has a black chest and very large black throat spot (but the entire throat is not black as in *granti* males at 67 mm.). The single old Gibara specimen (USNM 80415, a female, snout-vent length 64 mm.) agrees with the fresh material in lacking a black throat.

I suspect that these lizards are either still another (orange-throated) subspecies on the northern Oriente coast or represent extreme intergrades between *granti* to the east and an orange-throated subspecies farther west. The nearest unquestioned *granti* locality is Banes, 50 kilometers to the southeast. The nearest known population along the coast to the northwest is *citra* at Playa Santa Lucía, about 68 kilometers distant. Since *citra* has a gray-to-orange throat, it is possible that the Gibara lizards are *granti* x *citra* intergrades, but this section of Oriente coast is so poorly known that it seems imprudent to regard them as such at this time.

COMPARISONS: The only previously described subspecies of *A. auberi* with solid black chests and throats are *denticola*, far to the west in Pinar del Río Province, and *peradusta* in Las Villas Province. *A. a. denticola* and *A. a. granti* differ in many features, but the most striking are the expanding and fading median dorsal line and the gray band, bordered by black sides, on the upper surface of the tail in *granti*. *A. a. granti* differs from *peradusta* in lacking the black cheeks and neck and complete venter, and in being patterned dorsally. These two subspecies also differ markedly in mean number of fifteenth verticil scales (25.1 in *granti*, 28.9 in *peradusta*); *granti* ranks low and *peradusta* high in this character. The dorsal chromatic details (coupled with the darker reddish tan dorsum) will also serve to differentiate *granti* from all previously described subspecies. The dorsal coloration and pattern of *extraria* is somewhat comparable to that of *granti*, but the inconspicuous and brown lateral fields in *extraria* are distinct from the conspicuous lateral fields of *granti*.

REMARKS: *A. a. granti* is based in part on the long series collected by Major Chapman Grant at Banes. It is indeed a pleasure to associate his name with such a very distinctive subspecies, of whose existence he was well aware (Grant, 1960). Recently taken specimens have been secured

on *diente de perro* limestone with some trees and shrubs, Bahía de Miel), in shoreline vegetation both along the coast (northwest of Bahía de Taco) and in mesic riverine growth (Río Bay).

To the south, much of the range of *granti* is bordered by the Oriente massifs, and these mountain masses separate *granti* from the races on the south coast of the province, although I suspect that *granti* intergrades with the easternmost southern Oriente subspecies between Baracoa and Cabo Maisí. The *granti* from La Poa indicate that these lizards penetrate the northern slopes and foothills of the Cuchillas de Toa southwest of Baracoa to some extent. There are no specimens from the serpentine savannas in the region about Holguín; it would be most interesting to learn what subspecies occurs in this interior region — either *granti* (expected on the basis of proximity of range) or *llanensis* (expected because of similarity and continuity of habitat). The Gibara lizards may represent a marginal sample, in part intergradient with *granti*, of a distinctive subspecies inhabiting these interior Oriente plains.

Ameiva auberi sabulicolor, new subspecies

HOLOTYPE: AMNH 83941, an adult male, from 2.8 mi. E. Imías, Oriente Province, Cuba, taken August 21, 1959, one of a series collected by Ronald F. Klinikowski. Original number 8506.

PARATYPES (all from Oriente Province, Cuba); AMNH 83940, 83942-83943, same data as holotype; AMNH 83951, 4.6 mi. N. Cajobabo, December 28, 1958, J. R. Talada; AMNH 83938-83939, 4 mi. W. Baitiquirí, August 21, 1959, R. F. Klinikowski and B. L. Smith; IB 59-60, ASFS V11389, Baitiquirí, April 5, 1965, O. H. Garrido; AMNH 96457-96465, 33.8 mi. S.E. Guantánamo, August 27, 1960, R. F. Klinikowski and D. C. Leber; AMNH 96466-96468, 33.8 mi. S.E. Guantánamo, August 30, 1960, D. C. Leber; UMMZ 110184, United States Naval Base, February 20, 1954, T. M. Uzzell, Jr.; UMMZ 110203 (2 specimens), United States Naval Base, May 16, 1954, R. E. Etheridge; MCZ 68920, United States Naval Base, date unknown, R. V. Lando; UF 21879, United States Naval Base, October 18, 1965, J. C. Dickinson, Jr., and T. H. Patton; UIMNH 64431-64447, United States Naval Base, December, 1957, C. Grant; USNM 81665-81667, United States Naval Base, Cuzco Valley, August 16, 1930, P. Bartsch; USNM 59137-59140, United States Naval Base, Hospital Point, date unknown, J. B. Henderson and P. Bartsch; USNM 59166, United States Naval Base, Fisherman's Point, March 14, 1917, J. B. Henderson and P. Bartsch; USNM 81654, north side, Bahía de Guantánamo, August 14, 1930, P. Bartsch; USNM 59136, Guantánamo, March 18, 1917, J. B. Henderson and P. Bartsch; USNM 59163-59165, Guantánamo, date unknown, J. B. Henderson and P. Bartsch; USNM 139784-139787, Guantánamo, December, 1957, C. Grant; USNM 59192, Guantánamo Bay, date unknown, J. B. Henderson and P. Bartsch; USNM 81821, Boquerón, August 19, 1930, P. Bartsch.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of small size (males to 80 mm., females to 66 mm. snout-vent length), low number

of fourth-toe subdigital scales, high number of femoral pores, and low number of scales in the fifteenth caudal verticil; dorsum pale tan (sandy) to pale brown with median line pinkish anteriorly and gray posteriorly, fading and expanding posteriorly and continuing onto tail as a distinctly defined median gray caudal zone, dorsolateral lines tan and more or less straight, outlining lateral fields which are solid black (rarely with only a bare indication of reddish stippling along their margins), and chest and throat black.

DISTRIBUTION: The southeastern coast of Oriente Province, Cuba, from the vicinity of the city of Guantánamo and Boquerón, east to Cajobabo, and probably as far as Cabo Maisí.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 77 mm., tail 150 mm., partially regenerated; ventrals in 33 longitudinal and 10 transverse rows; fourth-toe subdigital scales 34 and 35 (total 69), femoral pores 14 and 15 (total 29), 25 scales in fifteenth caudal verticil. Dorsum very pale sandy tan with a pale (pinkish anteriorly, gray posteriorly) median stripe, which fades and expands posteriorly and becomes a sharply distinct bluish gray dorsal zone (about four scales wide) on the upper surface of the tail; sides of tail black, admixed with grayish scales basally, the black fading to darker gray distally; ventrolateral caudal pale stripe prominent on unregenerated portion of tail. Lateral fields solid black, bounded above and below by fairly prominent pale tan (above) or pale gray (below) lines, and with a faint stippling of reddish-to-tan scales, especially along the posterior margins of the fields. Sides grayish, marbled with darker gray vermiculations. Limbs sandy gray above with vague darker gray marblings. Throat, chest (to about level of fourteenth transverse row of ventrals), and anterior faces of forelimbs solid black. Venter pale bluish gray, paler on underside of tail.

VARIATION: The series of 47 *A. a. sabulicolor* has the following counts: longitudinal ventrals 30-34 (mode 32); rows of transverse ventrals 10; fourth-toe scales 62-81 (mean 72.8); femoral pores 23-31 (mean 26.7); fifteenth verticil 22-29 (mean 25.6). The largest male has a snout-vent length of 80 mm., the largest female 66 mm.

A. a. sabulicolor is one of a series of three races along the southern coast of Oriente Province between Cabo Maisí and Cabo Cruz. Its habitation of the most arid portion of this southern coast is reflected in its pallid coloration, varying from sandy or pale tan to pale brown. In juveniles and subadults the dorsum is somewhat darker brown than in full adults. The pink, grading to gray, median dorsal stripe and the tan dorsolateral stripes are constant features. In young specimens the lateral fields are solid black, and in adults there is only the barest indication of reddish-to-tan stippling along the very edges of the fields, especially in the posterior half. At times the lower sides have an additional longitudinal zone of tan paralleling the line that borders the lateral fields ventrally.

The black chest and throat are once again variable features. Specimens of *sabulicolor* were divided into three categories: (1) black chest and

throat; (2) black chest and some black on throat; (3) pale chest and throat. Of 38 males, 19 (snout-vent lengths 55 mm. to 80 mm. and thus including the largest male) fall into category 1. Category 2 includes eleven males with snout-vent lengths of 52 mm. to 74 mm., and category 3 includes eight males with snout-vent lengths from 50 mm. to 74 mm. Most (29 of 35) males with snout-vent lengths greater than 55 mm. have black chests and some indication of black on the throats. No females fall into category 1. In category 2 there are four females (snout-lengths between 50 mm. and 65 mm.) and in category 3 ten females (snout-vent lengths 52 mm. to 67 mm.). The smallest female has a black chest and some black on the throat, whereas many of the larger females (including the largest) lack any black pigment. The situation is inconclusive.

COMPARISONS: *A. a. sabulicolor* most resembles the races *granti* and *citra* from the northern coast of Camagüey and Oriente provinces. *A. a. sabulicolor* differs from both these northern subspecies in being much paler dorsally, and it differs additionally from *citra* in having a black throat and chest rather than a gray-to-orange throat. *Sabulicolor* differs as well in having solid black lateral fields (with at best some faint reddish stippling posteriorly), whereas both *citra* and *granti* regularly have some markings within the field itself. Both *extraria* and *sublesta* agree with *sabulicolor* in having an expanding and fading median dorsal line, but the throat in *extraria* is gray-to-diffuse orange, and brick-red in *sublesta*.

The southeastern coast of Oriente is typical of the arid tropics, and lies in the rain shadow of the Sierra de Purial and the Cuchillas de Toa and associated uplands. Although *A. a. sabulicolor* is primarily coastal, it does occur inland as far as the city of Guantánamo and north of the village of Cajobabo in the extreme eastern portion of its range. This latter locality is on the southern slopes of the Sierra de Purial and, although somewhat more mesic than the coast itself, is nonetheless arid. The elevation is probably less than 1000 feet. *Ameiva* was taken along the coast in such habitats as coastal scrub and arid woods, but in general the race appears not to be exceptionally abundant. The series from the United States Naval Base is the result of many years' collecting, and no single collector has secured large numbers of specimens there.

The range of *A. a. sabulicolor* is separated from that of *A. a. granti* by the interior Oriente massifs. As noted previously, I suspect that *sabulicolor* inhabits the xeric Cabo Maisí, and intergradation between it and *granti* occurs between Cabo Maisí and the region about Baracoa. Since the north Oriente coast is mesic, it seems likely that *sabulicolor* (which

inhabits the xeric southern coast) occurs on Cabo Maisí, rather than *granti* (which occupies the mesic north coast).

Ameiva auberi ustulata, new subspecies

HOLOTYPE: AMNH 83778, an adult male, from 7.8 mi. E. Siboney, Oriente Province, Cuba, taken July 21, 1959, one of two collected by Ronald F. Klinikowski and Barton L. Smith. Original number 7779.

PARATYPES (all from Oriente Province, Cuba): AMNH 83779, same data as holotype; USNM 29800, San Luis, February 15, 1902, W. Palmer; USNM 29796-29799, El Cobre, February, 1902, W. Palmer; AMNH 83763-83764, 6.5 km. S. Palma Soriano, July 11, 1959, R. F. Klinikowski; AMNH 96439, 4 km. N. Santiago de Cuba, August 12, 1960, R. F. Klinikowski; IB 4-9, ASFS V11390-V11391, Rancho Club, 4 km. N. Santiago de Cuba, March 25, 1965, O. H. Garrido; AMNH 20385-20387, Santiago de Cuba, December, 1920, G. Bosma; MCZ 6920, 84920, Santiago de Cuba, February 22, 1904, W. Robinson; UMMZ 90730 (2 specimens), Santiago de Cuba, Morro Castle, February, 1939, A. Vanderhorst; AMNH 83762, Aguadores, July 10, 1959, R. F. Klinikowski; AMNH 83765-83766, Aguadores, July 11, 1959, R. F. Klinikowski; AMNH 83767-83775, Aguadores, July 15, 1959, R. F. Klinikowski, B. L. Smith; AMNH 96440-96450, Aguadores, August 13, 1960, R. F. Klinikowski, D. C. Leber, J. D. Smallwood; AMNH 83776 (23 specimens), Playa Juraguá, 3.7 mi. E. Siboney, July 16, 1959, R. F. Klinikowski, A. Schwartz, B. L. Smith; AMNH 96451-96456, Playa Juraguá, 3.7 mi. E. Siboney, August 24, 1960, R. F. Klinikowski, D. C. Leber; AMNH 83780-83781, 18.2 km. E. Siboney, July 25, 1959, R. F. Klinikowski, B. L. Smith; AMNH 83782, 26.6 km. E. Siboney, July 25, 1959, R. F. Klinikowsky; AMNH 96419-96426, 9.4 mi. W. Laguna de Baconao, August 9, 1960, R. F. Klinikowski, J. D. Smallwood; AMNH 83783 (6 specimens), Laguna de Baconao, 21.8 mi. E Siboney, August 3, 1959, R. F. Klinikowski, A. Schwartz, B. L. Smith; AMNH 96437-96438, 0.7 mi. E. Laguna de Baconao, August 11, 1960, J. D. Smallwood; AMNH 96432-96436, 1.8 mi. E. Laguna de Baconao, August 11, 1960, R. F. Klinikowski, J. D. Smallwood; AMNH 96431, 2.8 mi. E. Laguna de Baconao, August 11, 1960, J. D. Smallwood; AMNH 96430, 3.7 mi. E. Laguna de Baconao, August 11, 1960, J. D. Smallwood; AMNH 96427-96429, 1.6 mi. NE Laguna de Baconao, August 11, 1960, R. F. Klinikowski, J. D. Smallwood.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of small size (males to 78 mm., females to 68 mm. snout-vent length), low number of fourth-toe subdigital scales, high number of femoral pores, and moderate number of scales in the fifteenth caudal verticil; dorsum brown with a yellow-to-gray median line, not (or only slightly) expanding posteriorly, remaining distinct, and forming a narrow dorsal stripe on the base of the tail which expands to form a broad dorsal caudal stripe, bounded laterally by black sides; dorsolateral lines gray to tan and prominent, outlining the solid black lateral fields above; lateral fields outlined below by a prominent tan-to-pale-gray lateral stripe, and chest and throat black.

DISTRIBUTION: Southern coast of Oriente Province between the Bahía de Santiago and the Bahía de Guantánamo, and occurring inland to the northwest of Santiago de Cuba at San Luis, El Cobre, and Palma Soriano, Cuba.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements

and counts: snout-vent length 78 mm., tail 126 mm., distal half regenerated; ventrals in 33 longitudinal and 10 transverse rows; fourth-toe subdigital scales 41 and 40 (total 81); femoral pores 13 and 14 (total 27); 27 scales in fifteenth caudal verticil. Dorsum brown with a prominent yellow median line which becomes gray at midbody, expands only slightly posteriorly, and forms a narrow, gray stripe (involving three scales) on the base of the tail, and then expands to form a rather broad, gray dorsal stripe on the unregenerated portion of the tail; caudal stripe bordered laterally by black sides of tail, which are basally much marked with tan to brown; ventrolateral caudal stripe white and very bold on unregenerated portion of tail. Lateral fields solid black bordered above by tan dorsolateral stripes and below by pale gray lateral stripes; a few small circular reddish spots in the lateral fields above the forelimb insertion and above the groin. Limbs brown above with vague gray marbling; posterior face of thighs with a bold white horizontal stripe bordered both above and below by coarse black-to-dark-gray vermiculations. Belly very pale blue; throat black, but not completely so.

VARIATION: The series of 85 *A. a. ustulata* has the following counts: longitudinal ventrals 30-36 (mode 32); rows of transverse ventrals 10; fourth-toe scales 64-85 (mean 72.8); femoral pores 22-32 (mean 26.2); fifteenth verticil 22-31 (mean 25.8). The largest male has a snout-vent length of 78 mm., the largest female 68 mm.

The description of the coloration and pattern of the holotype suffices for most of the series of *A. a. ustulata,* which, considering the large amount of material, is remarkably constant. The median dorsal line in many specimens shows no posterior expansion and is merely a median dorsal line, prominent and of the same width throughout its entire length. If there is posterior expansion, it is never so striking as in the races to the north and east. The lateral fields are solid black and very seldom show any included markings, the type being unusual in this respect. The two specimens from south of Palma Soriano have the lateral fields with scalloped edges. This may be the result of the influence of the next subspecies to the west (although the Palma Soriano specimens are not coastal), or the scalloped edges may represent the effect of some interior subspecies, as yet unsampled, from the valley of the Río Cauto. The Palma Soriano specimens were taken from the rather low pass that crosses the Sierra Maestra between Palma Soriano and Santiago de Cuba. The posterior thigh markings in the holotype of *ustulata* are not shown so boldly in all specimens, but there is always at least a fairly clear white transverse bar with some darker markings above and below. There is little or no difference in pigmentation and pattern between juveniles and adults, although all pattern elements seem a bit better defined in young individuals.

When all specimens of *ustulata* are categorized, the following data on black throats and chests may be summarized. In category 1, which

includes all specimens with black throats and chests, are included 29 males with snout-vent lengths from 55 mm. to 74 mm. In category 2 (chest black *or* with small black throat patch) are 15 males with snout-vent lengths from 55 mm. to 78 mm., and thus including the holotype — the largest male. In category 3 (no black on throat or chest) are 15 males with snout-vent lengths of 52 mm. to 74 mm. Most males (39 of 45) with snout-vent lengths in excess of 60 mm. have some black on the chest or throat. A single female (snout-vent length 58 mm. and thus not the largest female) falls into category 1. Only three females (snout-vent lengths 54 to 67 mm.) fall into category 2, whereas 26 females (snout-vent lengths 48 to 68 mm.) lack any black on chest or throat. In general, only rarely do female *ustulata* achieve any black pigmentation on throat or chest, although occasional specimens do so.

COMPARISONS: *A. a. ustulata* is obviously related to the more eastern *sabulicolor* but differs from it in being darker dorsally (pale tan and pale brown versus brown), in having the median dorsal line not fading and expanding posteriorly, and in having a rather clear-to-bold transverse thigh stripe. The condition of the median dorsal line in *ustulata* will differentiate it from the other eastern subspecies (*granti, citra, sublesta*) and the more western *extraria,* which have an expanding and fading median stripe. Of these, *extraria, sublesta,* and *citra* do not have black throats and chests. In some ways *ustulata* is rather like the far western *paulsoni,* but the black throat, gray median stripe, and black-sided and gray-surfaced tail of the former contrast with the cream throat, yellow lines, and unicolor tail of the latter. In the east, the shade of the median dorsal line differentiates *citra* (lemon-yellow to pale tan) from *sabulicolor* (pinkish to tan) and *ustulata* (pale yellow to gray), but not from *granti,* which also has the line pale yellow to gray.

REMARKS: *A. a. ustulata* is one of the few subspecies of *A. auberi* that occurs any significant distance inland and at any appreciable height. Comments have already been made on the specimens from Palma Soriano. The specimens from San Luis and El Cobre are from interior localities, and El Cobre is in a moderately high basin in the extreme eastern end of the Sierra Maestra (or in the Sierra del Cobre as it is locally known). San Luis lies in the Valle Central between the valley of the Río Cauto to the west and the Cuenca de Guantánamo to the east. The elevation of San Luis is only 171 meters (Marrero 1951:618). The Valle Central lies north of the Sierra Maestra (and north of the Sierra de Boniato and the Sierra de la Gran Piedra, which are Sierra

Maestra affiliates) and south of the Sierra de Nipe and the eastern Alturas de Baracoa.

The major portion of the range of *A. a. ustulata* lies to the south of the Sierra de la Gran Piedra and in its coastal rain shadow. The coast between the Bahía de Santiago and the Bahía de Guantánamo is arid, but somewhat less so than the coast to the east of Guantánamo. Ground lizards were collected in coastal scrub and in moderately moist gallery forest along the intermittent water courses near the coast. At Playa Juraguá, Aguadores, and Laguna de Baconao, *Ameiva* was abundant in shady woods, as well as along the borders of mangroves at the last-named locality.

The Bahía de Guantánamo separates the ranges of *A. a. ustulata* and *A. a. sabulicolor*, and the Bahía de Santiago separates the range of *A. a. ustulata* from the race to the west. The effect of these two bays upon populations of reptiles along the southern Oriente coast has been demonstrated by Schwartz (1960) in *Leiocephalus raviceps* and by Thomas and Schwartz (1966) in *Sphaerodactylus torrei*. It is not surprising that *A. auberi*, which also has an essentially coastal distribution in this area, has differentiated into three distinct subspecies in southern Oriente.

Ameiva auberi hardyi, new subspecies

HOLOTYPE: USNM 138468, an adult male, from Ocujal, Oriente Province, Cuba, taken August 31, 1956, one of a series collected by Jerry D. Hardy.

PARATYPES (all from Oriente Province, Cuba): USNM 138468-138471, same data as holotype. AMNH 83761, Cabo Cruz, July 5, 1959, B. L. Smith; IB 10-14 ASFS V11392-V11394, Verreón, Cabo Cruz, March 31, 1965, O. H. Garrido; USNM 138473, 5 mi. N. Cabo Cruz, September 6, 1956, J. D. Hardy; USNM 81678, Río Puercos, August 29, 1930, P. Bartsch; USNM 138472, Jucaral (not mapped), September 6, 1956, J. D. Hardy; AMNH 83777, 18.6 mi. W. Santiago de Cuba, July 17, 1959, B. L. Smith.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of moderate size (males to 93 mm., females to 76 mm.), high number of fourth-toe subdigital scales, moderate number of femoral pores, and low number of scales in the fifteenth caudal verticil; dorsum tan with pale-yellow-to-cream dorsal and dorsolateral lines, the median line expanding (although often not broadly) posteriorly and remaining distinct, lateral fields black with prominent red scallops and often with an included series of red spots, and throat orange.

DISTRIBUTION: Southwestern coast of Oriente Province, Cuba, from the vicinity of Cabo Cruz on the west presumably to the Bahía de Santiago on the east, but specimens are lacking from the area immediately to the west of the bay.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 93 mm., tail 201 mm.; ventrals in 32 longitudinal and 10 transverse rows; fourth-toe subdigital scales 39 and 38 (total 77); femoral pores 12 and 12 (total 24); 24 scales in the fifteenth caudal verticil. Dorsum

tan with a prominent median cream dorsal line, narrow anteriorly and wider (but not extremely so) posteriorly, extending onto the upper surfaces of the tail as a narrow dorsal blue stripe basally, and somewhat broader (four scales) posteriorly; a pair of dorsolateral tan lines above the lateral fields. Lateral fields extensively black and with large, reddish scallops ventrally, and irregular, reddish markings along the upper border; lower border of lateral fields with a faint grayish longitudinal line. Sides of tail black, sharply limiting the blue upper surface of the tail; ventrolateral caudal pale stripe prominent on the basal half of the tail. Lower sides extensively dark gray with some paler gray punctuations. Venter blue, under side of tail paler blue; throat very pale blue-gray in preserved specimen, but presumably pale orange in life. Upper side of limbs tan with little indication of darker marbling; no white transverse stripe along posterior border of thighs.

VARIATION: The series of 15 *A. a. hardyi* has the following counts: longitudinal ventrals 30-34 (mode 33); rows of transverse ventrals 10; fourth-toe scales 73-83 (mean 77.8); femoral pores 21-30 (mean 24.8); fifteenth verticil 24-29 (mean 25.6). The largest male has a snout-vent length of 93 mm., the largest female 76 mm.

I have seen but two examples of *A. a. hardyi* in life. One of these (AMNH 83777) is a juvenile on which I have no color data. The other (AMNH 83761) is from the extreme western end of the range at Cabo Cruz. Since the holotype and paratypes from between Cabo Cruz and west of Santiago are not black-throated, and since neither of the two specimens I have collected are black-throated (their throats were pale orange) I am assuming that all material from this stretch of coast is chromatically identical. Color slides and diagrams of specimens from Verreón, supplied by Sr. Garrido, confirm that the lizards at that locality are orange-throated. In general, material from farther west (Cabo Cruz and Río Puercos) has the median dorsal line more expanded than most specimens from the type locality, but even lizards from the Ocujal area have the dorsal line more expanded posteriorly than do specimens of *ustulata*. The lateral fields invariably are marked with reddish along both borders; one individual has an included longitudinal series of reddish dots in addition to the marginal scallops. Another specimen has a rather restricted series of ventral scallops. Even in the smallest specimen (snout-vent length 41 mm.) there are red markings within the lateral fields. No specimen shows any indication of black on the throat or chest.

COMPARISONS: The combination of orange throat and expanded median dorsal line separates *hardyi* from all other subspecies of *A. auberi* except possibly *citra* on the north coast of Camagüey and *extraria* on the northern *cayería* in Las Villas. *Ameiva a. hardyi* may be distinguished from the latter in having all dorsal pattern elements much more distinct, in having a darker dorsal ground color, and in having prominent lateral fields. *Ameiva a. hardyi* differs from *citra* in having prominent lateral

fields and the tail with black sides restricting a dorsal blue stripe. *Hardyi* differs in its larger size from its neighbor *ustulata* on the east (even though the series of *ustulata* is six times the size of the *hardyi* sample, none of the former in any way approaches the larger size of the 15 specimens of *hardyi*) in having an orange rather than black throat, and in other details of dorsal pattern and pigmentation.

REMARKS: *A. a. hardyi* is limited in distribution to the xeric coast south of the Sierra Maestra system between the Cabo Cruz region and Santiago de Cuba (the eastern portion of the range is hypothetical since there are no specimens from close to the Bahía de Santiago). At the type locality, Cooper (1958:13) reported securing specimens of *A. auberi* in the southern foothills of the Sierra Maestra as he and his party climbed toward Pico Turquino. The Ocujal region itself is arid. The AMNH specimen from Cabo Cruz was collected in a beach scrub habitat, and the lizard from 18.6 mi. west of Santiago de Cuba was from a similar situation. Many of the specimens of *A. a. hardyi* are from the vicinity of the type locality and were collected through the efforts of Jerry D. Hardy, for whom the subspecies is named.

Although there are no specimens of *hardyi* from close to the Bahía de Santiago to the west, it is possible that *hardyi* and *ustulata* intergrade somewhere about the western side of the bay. As noted in the discussion of *ustulata,* the two specimens from south of Palma Soriano differ somewhat from most *ustulata.* One, the largest specimen of that race, is a black-chested male. Both have extensive reddish markings in the lateral fields. If these specimens are *hardyi* x *ustulata* intergrades, then *hardyi* must somewhere avoid the eastern periphery of the Sierra Maestra to reach the Palma Soriano region. As previously stated, it is also possible that these two lizards are intergradient between *ustulata* and some subspecies to the north, rather than being *hardyi* x *ustulata* intergrades.

Ameiva auberi secta, new subspecies

HOLOTYPE: AMNH 82997, an adult male, from Playa de Rocas, between Bibijagua and Júcaro, Isla de Pinos, Habana Province, Cuba, taken July 24, 1958, one of a series collected by George R. Zug. Original number 6095.

PARATYPES (all from the Isla de Pinos, Habana Province, Cuba): AMNH 96299-96302, same data as holotype; AMNH 82996, just W. Nueva Gerona, east base, Sierra de las Casas, July 22, 1958, G. R. Zug; KU 55139, Nueva Gerona, June 6, 1953, T. H. Eaton; MCZ 10919, 10922-10923, Nueva Gerona, 1915, T. Barbour and W. S. Brooks; USNM 27982-27983, Nueva Gerona, July 6, 1900, W. Palmer and J. H. Riley; USNM 28041, Nueva Gerona, July 8, 1900, W. Palmer and J. H. Riley; KU 55145-55146, 3 mi. E. Nueva Gerona, June 6, 1953, T. H. Eaton; AMNH 82994 (5 specimens), Bibijagua, July 20, 1958, A. Schwartz, G. R.

Zug; AMNH 82998, Playa de Herradura, just N. Bibijagua, July 24, 1958, G. R. Zug; AMNH 82988 (2 specimens), 2 mi. S. Bibijagua, July 8, 1958, A. Schwartz, G. R. Zug; AMNH 78352-78355, 2 km. N. Santa Fé, December 24, 1957, E. B. Erickson, A. Schwartz, G. R. Zug; AMNH 78356-78361, Santa Fé, December 26, 1957, E. B. Erickson, W. H. Stitzell; ASFS V11395-V11397, Santa Fé, April 13, 1965, O. H. Garrido; AMNH 78362-78365, 1.5 mi. W. Santa Fé, December 26, 1957, E. B. Erickson, W. H. Stitzell, G. R. Zug; AMNH 78366-78373, east shore, Ensenada de la Siguanea, nr. Siguanea, December 27, 1957, E. B. Erickson, A. Schwartz, W. H. Stitzell, G. R. Zug; AMNH 82989, east shore, Ensenada de la Siguanea, nr. Siguanea, July 9, 1958, G. R. Zug; IB 142, IB 153-155, Hotel Colony, Siguanea, April 16, 1965, O. H. Garrido; MCZ 10949-10951, Los Indios, 1912, G. A. Link; AMNH 82990 (10 specimens), Playa de Buena Vista, July 12, 1958, A. Schwartz, G. R. Zug.

ASSOCIATED SPECIMENS: *Isla de Pinos*, 6 (CM 877-878, 881-882, 884, 886); *?Isla de Pinos*, 1 (CM 1088).

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of moderate size (males to 92 mm., females to 77 mm. snout-vent length), low number of fourth-toe subdigital scales, moderate number of femoral pores, and very low number of scales in the fifteenth caudal verticil; dorsum brown to reddish brown with prominent median and dorsolateral longitudinal yellow lines, lateral fields usually extensively black with scattered and isolated red dots, and throat black.

DISTRIBUTION: The northern two-thirds of the Isla de Pinos, north of the Ciénaga de Lanier.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 82 mm., tail 212 mm.; ventrals in 32 longitudinal and 10 transverse rows; fourth-toe subdigital scales 35 and 36 (total 71); femoral pores 12 and 13 (total 25); 26 scales in the fifteenth caudel verticil. Dorsum reddish brown with median and dorsolateral lines yellow and very bold. Lateral fields black with two longitudinal series of discrete red dots, and bordered below by a bold, grayish yellow line. Lower sides pale bluish gray with dark vermiculations. Limbs reddish brown above, heavily marbled with very dark brown; a clear white transverse line on the posterior face of the thigh, bordered above and below by wide black bands. Throat black, with very little black pigment extending onto first two or three transverse rows of ventrals. Tail grayish brown above, with a pair of whitish dorsolateral lines on its basal half; sides of tail dark gray or black, not clearly demarcating a dorsal paler longitudinal band; ventrolateral white caudal stripes distinct on basal half of tail. Belly dull grayish blue, under side of tail dark blue-gray.

VARIATION: The series of 57 *A. a. secta* has the following counts: longitudinal ventrals 29-34 (mode 31); rows of transverse ventrals 8 (5 specimens) -10; fourth-toe scales 63-86 (mean 69.6); femoral pores 21-31 (mean 24.8); fifteenth verticil 22-28 (mean 24.9). The largest male has a snout-vent length of 92 mm., the largest female 77 mm.

The dorsal color of *A. a. secta* varies from brown to rich reddish brown, and the median and dorsolateral lines are yellow and prominent at all ages. The lateral fields are somewhat variable as is customary.

They are always extensively black and usually have some included red markings, often, as described in the type, a series of discrete red spots. In some individuals the lateral fields are almost solid black, with some faint reddish stippling along the upper and lower margins, and some have the margins of the fields scalloped with reddish. The ventrolateral caudal pale stripes are bold, but only occasional individuals show any indications of white dorsolateral caudal stripes as does the holotype. There is often a bold black lateral line on the tail, delimited below by the ventrolateral caudal stripe and above by the dorsolateral caudal stripe (if present). The bold white transverse thigh stripe, surrounded on both sides by black patches, is fairly constant.

The series of *A. a. secta* was separated into three categories on the basis of chest and throat pigmentation: (1) black chest and throat; (2) black spot on chest and small black patch on throat; (3) no black on chest or throat. Of 32 males, 17 (snout-vent lengths 54 mm. to 92 mm., including the largest and smallest males) fall into category 1. Eleven males (snout-vent lengths 61 mm. to 91 mm.) are grouped in category 2, and only four males (snout-vent lengths 57 mm. to 65 mm.) are in category 3. Thus, most males (28 of 32), with snout-vent lengths of 54 mm. or more, have the chest black and some black on the throat. Of 27 females, two (snout-vent lengths 56 mm. and 75 mm.) are as heavily pigmented on throat and chest as most of the males, and fall into category 1. Four females (snout-vent lengths 57 mm. to 77 mm. and thus including the largest female) are included in category 2. Twenty females with snout-vent lengths from 52 mm. to 67 mm. lack any black on throat or chest and are in category 3. Once again, the situation with black throats and chests is anomalous. It can be stated at least that even small females at 56 mm. may achieve the totally black throat and chest of most males, but many larger females seem not to have reached this condition.

COMPARISONS: Of the Cuban mainland races, *A. a. secta* most closely resembles (as might be expected) *A. a. paulsoni*, which is geographically the most closely adjacent race. The two may be distinguished from each other by the cream throat and lateral field pattern (black with ventral margin scallops only) of *paulsoni* in contrast to the black throat and more variably patterned lateral fields of *secta*. The close relationship of the two races is shown by the low means of fourth toe scales (68.6 in *paulsoni*, 69.6 in *secta*).

Ameiva auberi secta is unique among Cuban subspecies in having a boldly lined brown or reddish brown dorsum without an expanding median dorsal line, and a black throat.

REMARKS: *A. a. secta* is widespread in many habitats, both interior and coastal, on the northern two-thirds of the Isla de Pinos. It was collected near Santa Fé on Malpais gravel in pinelands. coastally along beaches among *Ipomaea* (near Siguanea), in grass and cut mangrove trash (Buena Visita), and in broadleaf forest (Bibijagua). On two occasions we observed birds preying upon *A. a. secta*. Both episodes were diurnal and occurred at Playa de Buena Visita in cut-over mangroves adjacent to the coast. The predators were the Sparrow Hawk *(Falco sparverius sparverioides)* and Cuban Pygmy Owl *(Glaucidium siju vittatum)*. In both cases, the birds swooped down to the ground and returned to perch clutching a subadult *Ameiva*.

The relationships of *A. a. secta* with the southern Isla de Pinos subspecies will be discussed below.

Ameiva auberi marcida, new subspecies

HOLOTYPE: AMNH 82991, an adult male, from Jacksonville, Isla de Pinos, Habana Province, Cuba, taken July 14, 1958, one of a series collected by Albert Schwartz and George R. Zug. Original number 5840.

PARATYPES (all from the Isla de Pinos, Habana Province, Cuba): AMNH 96281-96298, same data as holotype; AMNH 78374-78375, Puerto Francés, December 30, 1957, E. B. Erickson, A. Schwartz, W. H. Stitzell, G. R. Zug; AMNH 82999 (9 specimens), Caleta Grande, July 26, 1958, A. Schwartz, G. R. Zug; AMNH 82992, 7 mi. E. Jacksonville, July 15, 1958, G. R. Zug; AMNH 82993 (8 specimens), Caleta de Carapachibey, July 18, 1958, A. Schwartz, G. R. Zug; IB 147-152, 162-163, CM 40647-40648, ASFS V11398-V11399, NMC 10064 (2 specimens), Guayacanal, April 17, 1965, O. H. Garrido; AMNH 82995 (17 specimens), Punta del Este, July 21, 1958, A. Schwartz, G. R. Zug; AMNH 82987 (14 specimens), Paso de Piedras, ca. 20 km. S.W. Santa Fé, July 2, 1958, A. Schwartz, G. R. Zug; IB 146, Cayo Piedras, April 14, 1965, O. H. Garrido.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of moderate size (males to 87 mm., females to 77 mm. snout-vent length), moderate number of fourth-toe subdigital scales and femoral pores, and low number of scales in the fifteenth caudal verticil; dorsum brown to tan with heads gray, median and dorsolateral lines tan, the median line very obscure, lateral fields black with brown included edging and consequent reduction of the black pigment, and throats pale blue (or with some black pigment; see discussion).

DISTRIBUTION: The southern third of the Isla de Pinos, south of the Ciénaga de Lanier, but including the Paso de Piedras which joins the north and south portions of the island across the Ciénaga.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 77 mm., tail 76 mm., terminal 20 mm. regenerated; ventrals in 30 longitudinal and 8 transverse rows; fourth-toe subdigital scales 37 and 35 (total 72); femoral pores 11 and 10 (total 21); 27 scales in the fifteenth caudal verticil. Dorsum tan with head distinctly gray and set off from dorsal coloration; median and dorsolateral stripes paler tan and median line not especially bold against ground color. Lateral fields much reduced because of en-

croachment of brownish pigment along their edges, so that black pigment is restricted to a short, sinuous line in the posterior half of the lateral field area. Lower sides gray, not blotched or vermiculate with darker. Tail dull grayish above, sides paler, and ventrolateral pale caudal stripe obscure. Throat pale blue and without any black pigment; belly and under side of tail pale blue. Limbs tan above and without darker reticulations or markings. A white transverse stripe on posterior face of thigh, surrounded by tannish gray above and below.

VARIATION: The series of 91 *A. a. marcida* has the following counts: longitudinal ventrals 30-34 (mode 32); rows of transverse ventrals 8 (6 specimens), 9 (1 specimen) or 10; fourth-toe scales 63-83 (mean 75.4); femoral pores 20-30 (mean 24.8); fifteenth verticil 22-29 (mean 25.0). The largest male has a snout-vent length of 87 mm., the largest female 77 mm.

The dorsal color of *A. a. marcida* varies from tan to brown. Adults are regularly the paler color and additionally have the head distinctly grayer than the back. The three dorsal lines are tan; the median stripe is always more obscure than the dorsolateral pair, and often becomes very faint or disappears on the posterior half of the trunk. The lateral fields are variable, but in most specimens there is more or less extensive brown pigment included along the margins of the fields, so that the more central black pigment is reduced in extent, often to as little as a sinuous or irregular line along the lateral field area. Juveniles have the dorsal lines more prominent than adults, but in subadults the lines have the faded appearance of fully adult specimens. The tails regularly lack the more prominent black or dark gray sides of the northern Isla de Pinos race (although there may be a rather narrow lateral dark area along the sides of the tail).

The throat and chest situation in *A. a marcida* is extremely peculiar. The specimens were divided into three categories: (1) black chest and throat; (2) black chest and black patch on throat; and (3) no black on chest or throat. Of 52 males, only six specimens (snout-vent lengths 65 mm. to 75 mm.) fall into category 1. Fifteen males (snout-vent lengths 62 mm. to 87 mm. and thus including the largest males) are included in category 2, and 31 males (snout-vent lengths 55 mm. to 85 mm.) lack any black throat or chest pigment, and have the throats and chests unicolor pale blue. In summary, slightly more than half the *marcida* males (31 of 52 specimens) lack any black pigment on either the chest or throat, but within the snout-vent-length range of these males are included both males with partially black throats and males with solid black throats and chests. The largest males have the chests black and the throats partially so.

No females are included in category 1. Only two females (snout-vent lengths 53 mm. and 72 mm.) are in category 2, and the balance of the

females (35 specimens), with snout-vent lengths from 48 mm. to 80 mm., lack any black throat pigment. In females, the vast majority of specimens lack black throats and chests. One of the two black-throated females (the larger) is from the Paso de Piedras, and might be interpreted as showing some genetic influence of *secta* from the north (in which race only a very few females are comparable to males in chest and throat pigmentation). But the smaller female is from Puerto Francés, at the extreme western tip of the island, and thus far removed from any direct *secta* influence. The only interpretation I can offer of the entire chest and throat picture of *marcida* is that the southern Isla de Pinos population is in the process of losing the black pigmentation on the throat and chest, but that many adults of both sexes do not attain the pigmentless condition.

COMPARISONS: *Marcida* is most pertinently compared with the more northern *secta*. Differences of throat pigmentation have just been reviewed. The majority of *marcida* can be separated from the majority of adult *secta* in that the former have pale blue rather than black throats. The dorsal coloration and pattern of the two races is surprisingly different; *marcida* is in general faded and lacks the bold median and dorsolateral lines of *secta* as well as the prominent lateral fields with red markings. No other subspecies has a pale blue throat. Superficially there are resemblances between *marcida* and *extraria*: both are rather pale and have a poorly developed median line. The throat color in *extraria* is gray to diffuse dull orange.

A. a. marcida is widely distributed on the southern portion of the Isla de Pinos, from Puerto Francés in the west to Punta del Este in the east. The specimens from Paso de Piedras are clearly *marcida*, and inter gradation between *marcida* and *secta* presumably occurs to the north of the Paso de Piedras, since only in this region is there an obvious possibility of contact between the northern and southern populations of *A. auberi*. The northern and southern portions of the Isla de Pinos are almost completely separated by the Ciénaga de Lanier. On the southern part of the island, *marcida* was collected in beach scrub (Puerto Francés), in palm woods and broadleaf forest (Jacksonville and Punta del Este), and in rich, moist broadleaf forest (Paso de Piedras).

Ameiva auberi zugi, new subspecies

HOLOTYPE: AMNH 83003, an adult male, from Cayo Largo, Archipiélago de los Canarreos, Habana Province, Cuba, taken July 30, 1958, one of a series collected by Albert Schwartz and George R. Zug. Original number 6221.

PARATYPES (all from the Archipiélago de los Canarreos): AMNH 96303-96310, same data as holotype; AMNH 83000 (9 specimens), Cayo Matías, July 18, 1958,

A. Schwartz, G. R. Zug; USNM 81718-81719, Cayo Matías, September 22, 1930, P. Bartsch; AMNH 83001 (6 specimens), Cayo Hicacos, July 28, 1958, G. R. Zug; AMNH 83002 (3 specimens), Cayo Avalos, July 29, 1958, G. R. Zug; USNM 81766, Cayo Avalos, September 21, 1930, P. Bartsch; IB 75, 78, ASFS V11400-V11401, Cayo Largo (del Sur), April 28, 1966, O. H. Garrido; IB 80-82, CM 40649-40650, Cayo Largo (del Sur), May 20, 1965, O. H. Garrido.

ASSOCIATED SPECIMENS: *Cuba, Habana Province,* Archipiélago de los Canarreos, Cayo Cantiles, AMNH 93852, IB 72-74; Cayo Cantiles, Punta del Negrito, IB 1340; Cayo Cantiles, La Aguada de la Laguna del Inglés, IB 1330-1336, 1338-1339, ASFS V11402-V11406.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of small size (males to 82 mm., females to 65 mm. snout-vent length), low number of fourth-toe subdigital scales and femoral pores, and very low number of scales in the fifteenth caudal verticil; dorsum pale sandy to tan, all dorsal lines pale yellowish tan, not especially contrasting with the dorsal ground color and fading posteriorly, lateral fields extensively black, with tan edging or at times included discrete tan dots, and throats white to pale blue (except on Cayo Cantiles; see discussion).

DISTRIBUTION: Known from five cays (Matías, Hicacos, Avalos, Cantiles, Largo) in the Archipiélago de los Canarreos, east of Punta del Este, Isla de Pinos.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 66 mm., tail 51 mm., broken; ventrals in 33 longitudinal and 10 transverse rows; fourth-toe subdigital scales 37 and 36 (total 73); femoral pores 13 and 13 (total 26); 26 scales in the fifteenth caudal verticil. Dorsum pale sandy with median and dorsolateral lines pale yellowish tan and barely distinguishable from dorsal ground color, all three lines fading out on posterior half of trunk; head concolor with dorsum. Lateral fields black with a dorsal and ventral series of tan and irregular dots or scallops restricting the black pigment to a central irregularly-edged band; lateral fields bordered ventrally by a moderately bold pale tan lateral line; lower sides pale sandy, grading to blue ventrally, and without dark markings or vermiculations. Tail grayish tan dorsally, with a moderately well defined lateral black stripe which fades out distally; ventrolateral caudal white stripe fairly conspicuous. Throat pale blue; venter pale blue laterally, white medially; under side of tail pale blue. Limbs concolor with back and without prominent darker vermiculations or markings.

VARIATION: The series of 55 *A. a. zugi* has the following counts: longitudinal ventrals 30-34 (modes 32 and 33); rows of transverse ventrals 8 (1 specimen) — 10; fourth-toe scales 64-79 (mean 72.8); femoral pores 21-28 (mean 24.9); fifteenth verticil 22-28 (mean 24.9). The largest male is from Cayo Cantiles and has a snout-vent length of 82 mm.; the largest females are from Cayo Largo and Cayo Cantiles and have a snout-vent length of 65 mm.

As might be expected, there is some variation between specimens of *zugi* from the various cays. Material from Cayo Cantiles is the most aberrant. Specimens from the more western islands (Matías, Hicacos, Avalos), which are much closer to the Isla de Pinos, are somewhat darker dorsally and are intermediate in this character between *marcida* and *zugi,* but are closer to the latter subspecies. Specimens from Cayo

Largo are obviously the most extreme and have a distinctly bleached or faded appearance. In no adults from any cay are the dorsal lines conspicuous, and these regularly fade out posteriorly to become lost in the dorsal ground color. The lateral fields are black centrally and have some tan-to-sandy markings along the upper and lower margins. In one specimen from Cayo Avalos, there is no black pigment on the lateral fields, these areas being concolor with the back. In general, the throats vary from white to very pale blue, and the venter is white centrally and pale blue laterally. The white transverse thigh stripe is usually present and surrounded by grayish tan. The tails are grayish tan to grayish dorsally in adults but are blue in juveniles.

The series from Cayo Cantiles, recently collected by Sr. Garrido, is most interesting in that the series contains five individuals that have some black pigment on the throat and chest. Most extreme is a male (IB 1334, snout-vent length 70 mm. and thus not the largest male) that has a solid-black throat spot and some black on the mesoptychium and chest. A second male (IB 72, snout-vent length 80 mm., again not the largest male) has black on the posterior throat and mesoptychium and some black on the chest. The next two males (IB 1335, ASFS V11406, snout-vent lengths 81 mm. and 82 mm.) have some black on the mesoptychium and chest and scattered black scales on the throat. The final male (ASFS V11405, snout-vent length 68 mm.) has some black pigment on the mesoptychium only. No specimen of *zugi* from any other cay shows any indication of having black throat or chest pigment. Although the situation with the Cantiles lizards may well be comparable to that of *extorris* and *extraria* — i.e., assumption that the Cantiles *Ameiva* are a local derivative from a more widespread form (*zugi*) — I have have not named the Cantiles lizards as a distinct subspecies. I did not do so because (1) the population on Cantiles cannot be interpreted as being black-throated since this feature occurs in only a small portion of the population, and (2) in contrast to *extorris* and *extraria*, the Cantiles lizards are "surrounded" both to the east and west along the linear Archipiélago de los Canarreos by more orthodox pale throated *zugi*. If one constructs a series (based upon the occurrence of black throats and chests) of the Isla de Pinos-associated subspecies, the series is *secta-marcida-zugi*. This is almost surely a natural evolutionary sequence as well. *A. a. secta* is predominantly black-throated, *marcida* has a lesser proportion of black-throated individuals, and in *zugi*, black-throatedness occurs only as a rarity on one cay within the chain. Just as *marcida* seems to be in the process of losing its capabilities for black-throatedness, so in *zugi* this potentiality has been lost almost completely

except for occasional individuals, and apparently only on Cayo Cantiles. It seems best, under these circumstances, to consider the Cantiles lizards as slightly aberrant *zugi*. My opinions on this matter might well be changed if it could be demonstrated that *Ameiva* on the cays (Avalos, Matías, Hicacos) between Cantiles and Punta del Este also had some black-throated individuals, but the fairly extensive material (21 specimens) available from these cays does not show any such tendencies.

COMPARISONS: The only other Cuban subspecies comparable to *zugi* in dorsal coloration, pattern, and size is *extraria* from the northern *cayería* of Las Villas Province. *Extraria* has the throat gray-to-dull orange, never white or pale blue, and has brown and inconspicuous lateral fields. Compared with *marcida* of the adjacent southern coast of the Isla de Pinos, *zugi* is distinctly paler and has the dorsal lines much fainter. The throat in *marcida* is pale blue or black. The means of fourth-toe scales in *extraria* (76.3) and *zugi* (72.8) are significantly distinct, whereas the mean of *marcida* (75.4) is closer to that of *zugi*, but still significantly different.

REMARKS: The Archipiélago de los Canarreos is a series of cays which extends roughly from Punta del Este eastward to Cayo Largo for a distance of about 145 kilometers. The keys have been generally discussed by myself (Schwartz, 1959a:117-118) in the description of the endemic subspecies *Leiocephalus cubensis pambasileus*. No *Ameiva* were collected on Cayo Campos or Cayo del Rosario, both of which I visited with George Zug, for whom the cays' race is named. On Cayo Largo, *A. a. zugi* was secured on sun-baked mudflats adjacent to mangroves at the western end of the island, and on Cayo Matías and Cayo Avalos ground lizards were secured in the xerophytic vegetation that covers many of these cays. Cayo Cantiles, however, is rocky and covered with practically impenetrable jungle, and we secured only one *Ameiva* there along the very rocky and hazardous shoreline. Sutcliffe (1952:5-6) reported the occurrence of *Ameiva* (as *Ameiva thoracica*) on Cayo Largo and on Cayo Majas Chico, a small satellite of Cayo Largo. No specimens are available from the latter cay but I assume that they are assignable to *A. a. zugi*.

A. a. zugi is obviously a derivative of *A. a. marcida* on the southern part of the Isla de Pinos. Presumably the former race is widespread on other islands of the Archipiélago de los Canarreos, but the apparent absence of *Ameiva* on some cays we visited is paralleled by the absence of *L. cubensis* on some other cays. *Leiocephalus* was not collected on Matías, Avalos, Cantiles, Rosario, or Largo, whereas *Ameiva* was not

collected on Campos or Rosario. Island size surely is not a factor in such vagaries of distribution, since both Campos and Rosario are much larger than Matías and Avalos where *Ameiva* has been collected.

Ameiva auberi galbiceps, new subspecies

HOLOTYPE: AMNH 78058, an adult male, from southernmost point of large cay, 3 km. N.W. Cayo Cachiboca, Laberinto de las Doce Leguas, Camagüey Province, Cuba, taken August 24, 1957, one of a series collected by William H. Gehrmann and John R. Feick. Original number 4320.

PARATYPES (all from the Laberinto de las Doce Leguas, Camagüey Province, Cuba): AMNH 78049-78057, 78059-78064, same data as holotype; USNM 81707, Cayo Caballones, September 9, 1930, P. Bartsch; USNM 81705-81706, Pilot Point, Cayo Anclitas, September 9, 1930, P. Bartsch; AMNH 78046-78048, Cayo Cachiboca, August 25, 1957, W. H. Gehrmann, J. R. Feick; AMNH 78065-78068, unnamed cay, 20° 37′ N. latitude, 78° 32′ W. longitude, August 25, 1957, W. H. Gehrmann, J. R. Feick; USNM 81700, cay 78° 33′ W. longitude (= same cay as AMNH 78065-78068), September 7, 1930, P. Bartsch; MCZ 57936, Cayo Cabeza del Este, August 15-16, 1957, R. Molina and R. Ruibal; USNM 81701-81703, southeast end, Doce Leguas (= Cayo Cabeza del Este), September 7, 1930, P. Bartsch; USNM 81704, "Doce Leguas," September 8, 1930, P. Bartsch.

DIAGNOSIS: A Cuban subspecies of *A. auberi* characterized by a combination of moderate size (males to 87 mm., females to 75 mm. snout-vent length), moderate number of fourth-toe subdigital scales and femoral pores, high number of scales in the fifteenth caudal verticil; dorsum tan, often with the dorsal fields with some vague grayish marbling especially in their posterior halves, head and neck distinctly yellow-green (almost chartreuse), dorsal lines yellowish tan, median line fading posteriorly, lateral fields black with two or three longitudinal included series of reddish tan spots, and throats yellow-green.

DISTRIBUTION: Known from six cays in the Laberinto de las Doce Leguas off the southern coast of Camagüey Province, Cuba.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 87 mm., tail 168 mm.; ventrals in 33 longitudinal and 10 transverse rows; fourth-toe subdigital scales 38 and 37 (total 75); femoral pores 12 and 13 (total 25); 28 scales in the fifteenth caudal verticil. Dorsum tan with median and dorsolateral lines yellowish tan, the median line visible only far anteriorly, but the dorsolateral lines fairly prominent above the lateral fields; head and neck distinctly yellowish green and in striking contrast to the dorsal color; dorsal fields with very vague grayish marbling, especially posteriorly. Lateral fields extensively black with about three longitudinal series of reddish tan spots which are fused vertically to give a series of more or less vertical reddish tan bars, although the spots often maintain their individual identities and are not fused; lateral fields bordered below by a pale lateral line. Lower sides blue-gray without prominent tigroid markings. Tail tan above, and with the pale ventrolateral caudal stripe fairly prominent basally. Limbs tan above, marbled with gray vermiculations; pale transverse thigh stripe obscure and surrounded by grayish tan areas both above and below. Throat yellow-green; belly pale blue centrally, darker blue laterally; under side of tail pale blue to whitish.

VARIATION: The series of 29 *A. a. galbiceps* has the following counts: longi-

tudinal ventrals 31-35 (mode 33); rows of transverse ventrals 10-12 (1 specimen); fourth-toe scales 70-81 (mean 74.7); femoral pores 21-28 (mean 25.3); fifteenth verticil 25-30 (mean 27.8). The largest male is from the large cay 3 km. N.W. Cayo Cachiboca and has a snout-vent length of 87 mm. The largest female is from the same cay and has a snout-vent length of 75 mm.

Throughout its range, *A. a. galbiceps* is fairly constant in coloration and pattern. The yellow-green head, neck, and throat are regular features; no other subspecies of *A. auberi* has such a brightly marked head or a yellow-green throat. Many specimens (both adults and subadults) have the dorsal fields with rather distinct grayish marbling, but these markings are very faint in the holotype and in some other specimens. The lateral fields may have the series of reddish tan spots discrete or the spots may be fused, or partially fused, with one another as in the holotype. The black area in the lateral fields is seldom extremely reduced or restricted, however, except in the specimen from Cayo Caballones at the western end of the Doce Leguas. The dorsal lines are yellowish tan and are fairly prominent at least anteriorly. The median line fades posteriorly and is lost in the dorsal ground color.

COMPARISONS: *A. a. galbiceps* in dorsal pattern resembles *A. a. llanensis* from the serpentine savannas of Camagüey Province. Both have some grayish-to-brownish markings in the dorsal fields and are the only subspecies that have this feature. The yellow-green head and throat of *galbiceps* is a distinctive feature which occurs in no other subspecies; the throat in *llanensis* is pale orange. The yellow throat of *procer* far to the west on the Cuban mainland is similar to that of *galbiceps,* but the latter race has the throat pigmentation distinctly more green, is much smaller, and has persistent dorsal lines in the adult.

REMARKS: The series of *A. a. galbiceps* was collected principally through the efforts of Gehrmann and Feick. The lizards were moderately abundant on all the cays visited and were at once recognized as something quite distinctive from any populations that had been sampled on the mainland. The absence of *A. auberi* material from much of the province of Camagüey, especially the southern coast, makes comparison of *galbiceps* with mainland populations difficult. It is interesting that no *A. auberi* have been collected by us or others throughout much of Camagüey Province, despite apparently suitable habitats in very many areas. The dorsal field markings in *galbiceps* and *llanensis* suggest that they are related, but the ranges of the two are widely separated today. It is possible that *llanensis* occurs much farther to the south than present records indicate, however. The scrub habitat of *galbiceps* is in contrast to the savanna habitat of *llanensis.*

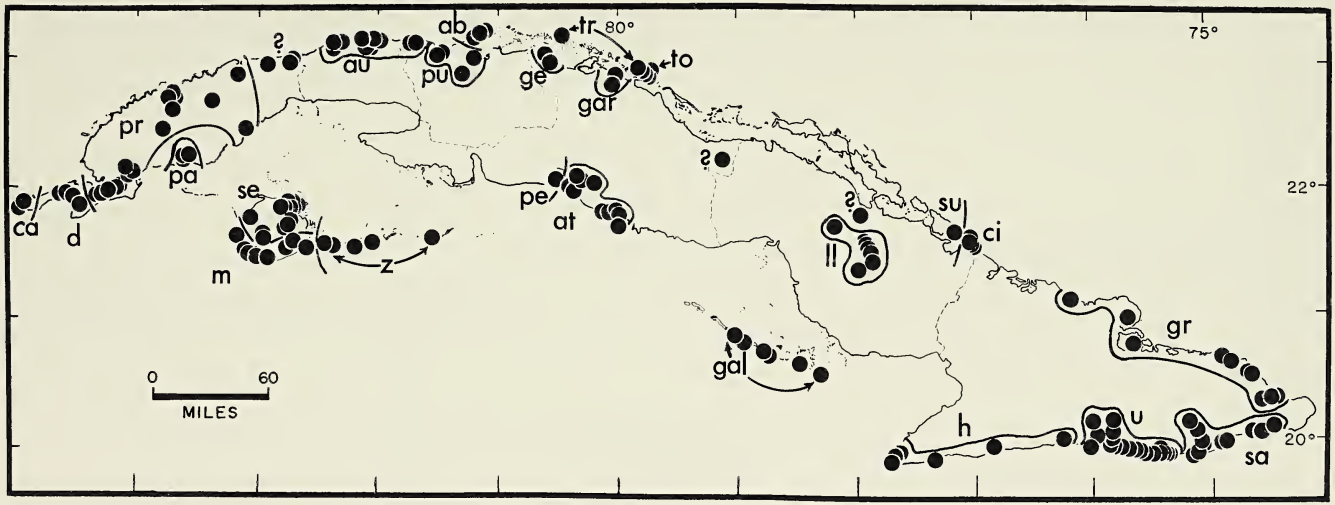


Fig. 1. Map of Cuba and the Isla de Pinos, showing distributions of subspecies of *Ameiva auberi*, as follows (west to east): ca — *cacuminis;* d — *denticola;* pr — *procer;* pa — *paulsoni;* au — *auberi;* pu — *pullata;* ab — *abducta;* ge — *gemmea;* gar — *garridoi;* tr — *extraria;* to — *extorris;* at — *atrothorax;* pe — *peradusta;* ll — *llanensis;* su — *sublesta;* ci — *citra;* gr — *granti;* sa — *sabulicolor;* u — *ustulata;* h — *hardyi;* se — *secta;* m — *marcida;* z — *zugi;* gal — *galbiceps.* Three questioned areas and localities (northeastern Pinar del Río, eastern Las Villas, northern Camagüey) represent localities whose populations remain unassigned subspecifically.

TABLE 1

SUBSPECIES OF *A. auberi* RANKED BY SNOUT-VENT LENGTH (IN MILLIMETERS) OF LARGEST MALE

Subspecies	Largest Male	Largest Female
procer	136	115
atrothorax	126	93
garridoi	110	70
gemmea	105	97
peradusta	105	76
denticola	96	78
granti	93	82
secta	93	77
auberi	92	88
hardyi	92	76
paulsoni	92	75
citra	92	72
llanensis	90	78
marcida	87	77
galbiceps	87	75
abducta	87	68
zugi	82	65
pullata	81	81
sublesta	81	67
sabulicolor	80	66
cacuminis	80	60
extraria	79	68
ustulata	78	68
extorris	76	—

TABLE 2

SUBSPECIES OF *A. auberi* RANKED ACCORDING TO MEAN NUMBER OF FEMORAL PORES

Subspecies	N	Femoral Pores
garridoi	23	27.6 (25 - 32)
peradusta	28	27.2 (23 - 33)
denticola	59	27.1 (23 - 31)
atrothorax	65	26.8 (21 - 32)
sabulicolor	47	26.7 (23 - 31)
auberi	33	26.6 (23 - 31)
pullata	24	26.3 (23 - 31)
sublesta	12	26.3 (25 - 28)
ustulata	85	26.2 (22 - 32)
procer	62	26.0 (21 - 31)
gemmea	15	25.9 (22 - 30)

(Continued next page)

TABLE 2 (Continued)

SUBSPECIES OF *A. auberi* RANKED ACCORDING TO MEAN NUMBER OF FEMORAL PORES

granti	54	25.7 (21 - 31)
cacuminis	17	25.6 (24 - 29)
abducta	30	25.4 (21 - 30)
galbiceps	29	25.3 (21 - 28)
extorris	7	25.3 (24 - 28)
zugi	55	24.9 (21 - 28)
hardyi	15	24.8 (21 - 30)
secta	57	24.8 (21 - 31)
marcida	91	24.8 (20 - 30)
citra	31	24.3 (20 - 29)
paulsoni	28	24.2 (20 - 28)
extraria	55	23.8 (21 - 27)
llanensis	13	23.8 (21 - 26)

TABLE 3

SUBSPECIES OF *A. auberi* RANKED ACCORDING TO MEANS OF NUMBER OF SCALES IN FIFTEENTH CAUDAL VERTICIL; N AS IN TABLE 2

Subspecies	Fifteenth verticil
atrothorax	29.5 (25 - 33)
peradusta	28.9 (26 - 32)
auberi	28.2 (26 - 31)
denticola	28.0 (24 - 33)
sublesta	27.9 (26 - 30)
garridoi	27.9 (26 - 30)
galbiceps	27.8 (25 - 30)
llanensis	27.7 (25 - 30)
abducta	27.6 (24 - 29)
procer	27.3 (24 - 31)
pullata	26.8 (24 - 29)
extraria	26.5 (23 - 30)
cacuminis	26.4 (24 - 29)
gemmea	25.9 (24 - 30)
citra	25.8 (24 - 29)
ustulata	25.8 (22 - 31)
paulsoni	25.6 (24 - 27)
sabulicolor	25.6 (22 - 29)
hardyi	25.6 (24 - 29)
extorris	25.4 (24 - 27)
granti	25.1 (22 - 29)
marcida	25.0 (22 - 29)
secta	24.9 (22 - 28)
zugi	24.9 (22 - 28)

TABL

			cacuminis	*denticola*	*procer*	*paulsoni*	*auberi*	*pullata*	*abducta*
cacuminis	16	75.1 ± 3.00	X	—	—	+	—	—	—
denticola	41	76.4 ± 1.38		X	+	+	—	—	—
procer	56	71.9 ± 1.35			X	—	+	—	—
paulsoni	22	68.6 ± 1.84				X	+	+	+
auberi	26	76.3 ± 2.46					X	—	—
pullata	21	75.0 ± 1.80						X	—
abducta	21	75.2 ± 2.14							X
gemmea	12	73.8 ± 2.36							
garridoi	22	78.3 ± 2.19							
extraria	44	76.3 ± 0.87							
atrothorax	51	79.0 ± 1.18							
peradusta	27	79.9 ± 1.64							
citra	21	77.2 ± 2.18							
granti	48	75.9 ± 1.69							
sabulicolor	43	72.8 ± 1.32							
ustulata	60	72.8 ± 1.10							
hardyi	10	77.8 ± 2.12							
secta	49	69.6 ± 1.34							
marcida	72	75.4 ± 1.23							
zugi	46	72.8 ± 1.02							
galbiceps	20	74.7 ± 1.60							

Subspecies arranged from west to east, three subspecies (*llar* *extorris, sublesta*) not included because of small sample si for each sample indicated in first column, means and two sta

RISON OF FOURTH-TOE SUBDIGITAL SCALE COUNTS IN CUBAN *Ameiva auberi*

	atrothorax	*peradusta*	*citra*	*granti*	*sabulicolor*	*ustulata*	*hardyi*	*secta*	*marcida*	*zugi*	*galbiceps*	
-	—	+	—	—	—	—	—	+	—	—	—	*cacuminis*
-	+	+	—	—	+	+	—	+	—	—	—	*denticola*
-	+	+	+	+	—	—	+	—	+	—	—	*procer*
-	+	+	+	+	+	+	+	—	+	+	+	*paulsoni*
-	—	+	—	—	—	—	+	+	—	+	—	*auberi*
-	+	+	—	—	—	—	—	+	—	—	—	*pullata*
-	+	+	—	—	—	—	—	+	—	—	—	*abducta*
-	+	+	—	—	—	—	—	+	—	—	—	*gemmea*
-	—	—	—	—	+	+	—	+	—	+	—	*garridoi*
ζ	+	+	—	—	+	+	—	+	—	+	—	*extraria*
	X	—	—	+	+	+	—	+	+	+	+	*atrothorax*
		X	—	—	+	+	—	+	+	+	+	*peradusta*
			X	—	+	+	—	+	—	+	—	*citra*
				X	+	+	—	+	—	+	—	*granti*
					X	—	+	+	+	—	—	*sabulicolor*
						X	+	+	+	—	—	*ustulata*
							X	+	—	+	—	*hardyi*
								X	+	+	+	*secta*
									X	+	—	*marcida*
										X	—	*zugi*
											X	*galbiceps*

rs f means in second column. A "+" in table indicates that the
species involved differ significantly (non-overlap of two
d errors of mean); a "—" indicates no statistical difference.

TABLE 1. COMPARISON OF FOURTH-TOE SUBDIGITAL SCALE COUNTS IN CUBAN *Ameiva auberi*

			cacuminis	*denticola*	*procer*	*paulsoni*	*auberi*	*pullata*	*abducta*	*extraria*	*atrothorax*	*peradusta*	*citra*	*granti*	*sabulicolor*	*ustulata*	*hardyi*	*secta*	*marcida*	*zugi*	*galbiceps*	
cacuminis	16	75.1 ± 3.00	X	—	—	+	—	—	—	—	—	+	—	—	—	—	—	+	—	—	—	*cacuminis*
denticola	41	76.4 ± 1.38		X	+	+	—	—	—	—	+	+	—	—	+	+	—	+	—	—	—	*denticola*
procer	56	71.9 ± 1.35			X	—	+	—	—	+	+	+	+	+	—	—	+	—	+	—	—	*procer*
paulsoni	22	68.6 ± 1.84				X	+	+	+	+	+	+	+	+	+	+	+	—	+	+	+	*paulsoni*
auberi	26	76.3 ± 2.46					X	—	—	—	—	+	—	—	—	—	+	+	—	+	—	*auberi*
pullata	21	75.0 ± 1.80						X	—	—	+	+	—	—	—	—	—	+	—	—	—	*pullata*
abducta	21	75.2 ± 2.14							X	—	+	+	—	—	—	—	—	+	—	—	—	*abducta*
gemmea	12	73.8 ± 2.36								—	+	+	—	—	—	—	—	+	—	—	—	*gemmea*
garridoi	22	78.3 ± 2.19								—	—	—	—	—	+	+	—	+	—	+	—	*garridoi*
extraria	44	76.3 ± 0.87								X	+	+	—	—	+	+	—	+	—	+	—	*extraria*
atrothorax	51	79.0 ± 1.18									X	—	—	+	+	+	—	+	+	+	+	*atrothorax*
peradusta	27	79.9 ± 1.64										X	—	—	+	+	—	+	+	+	+	*peradusta*
citra	21	77.2 ± 2.18											X	—	+	+	—	+	—	+	—	*citra*
granti	48	75.9 ± 1.69												X	+	+	—	+	—	+	—	*granti*
sabulicolor	43	72.8 ± 1.32													X	—	+	+	+	—	—	*sabulicolor*
ustulata	60	72.8 ± 1.10														X	+	+	+	—	—	*ustulata*
hardyi	10	77.8 ± 2.12															X	+	—	+	—	*hardyi*
secta	49	69.6 ± 1.34																X	+	+	+	*secta*
marcida	72	75.4 ± 1.23																	X	+	—	*marcida*
zugi	46	72.8 ± 1.02																		X	—	*zugi*
galbiceps	20	74.7 ± 1.60																			X	*galbiceps*

Subspecies arranged from west to east, three subspecies (*Ilanen*[illegible]ss of means in second column. A "+" in table indicates that the *extorris, sublesta*) not included because of small sample size. subspecies involved differ significantly (non-overlap of two for each sample indicated in first column, means and two standard errors of mean); a "—" indicates no statistical difference.

II. THE BAHAMIAN SUBSPECIES

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Introduction

Ameiva thoracica Cope was described in 1862 from a series of specimens collected on New Providence Island in the Bahamas by Dr. H. C. Wood, Jr. In Stejneger's early revision of the Bahamian land-reptile fauna (*in* Shattuck, 1905),[1] *A. thoracica* was listed from Eleuthera Island, Andros Island, and Great Abaco Island, in addition to New Providence. Barbour and Noble (1915) correctly questioned the Great Abaco record, and Barbour (1916) reported *thoracica* from several localities in the Exuma Cays. Cochran (1934) recorded specimens collected by Bartsch, supposedly from the Ragged Islands and Crooked Island. By the time of Barbour's "*Third List of Antillean Reptiles and Amphibians*" (1937), *Ameiva thoracica* was firmly established as "widespread in the northern and central portions of the Bahama Archipelago." Despite the relatively long history of taxonomic recognition of *Ameiva thoracica,* infraspecific variation in this common Bahamian species has never been closely studied. Only the astute Thomas Barbour, who probably saw more *thoracica* than any other herpetologist of his day, wrote "with much larger series *Ameiva thoracica* may be shown to break up into several races" (Barbour and Shreve, 1935).

In July, 1965, Neil D. Richmond of Carnegie Museum participated in the Fourth Expedition of the Bahamas Biological Survey, under the auspices of the American Museum of Natural History and the Office of Naval Research [Project No. 552(07)]. Among the specimens collected during this expedition were series of *Ameiva auberi* from widely scattered localities in the northern Bahamas, including the Berry Islands, Andros Island, the Exuma Cays, Long Island, the Ragged Islands, and Green Cay. With this fresh material available for study it became obvious that Bahamian *auberi* exhibits a surprising range of variation in color and pattern. Preliminary observations on these specimens were extended to include examination of color and scale-count characters in *auberi* from throughout the Great Bahama Bank. The inter-population differentiation so immediately apparent in color patterns was substantiated and quantified by the data on scutellation and size. The variants occur as internally consistent geographic units, which are here given taxonomic recognition as subspecies.

1. Bibliography follows section III.

It is not surprising that the well-marked Bahamian subspecies of *Ameiva auberi* have previously escaped detection. The most important and obvious characters lie in fugitive elements of color and pattern which are inevitably destroyed by preservation. The quantitative treatment and statistical comparsion of scale counts are taxonomic tools only recently applied in studies of the macroteiid genera *Ameiva* and *Cnemidophorus,* and have not previously been used in treatments of *A. auberi.* Moreover, despite the accumulation of Bahamian *Ameiva* in many collections, adequate series of fresh and well-preserved specimens from many parts of the species' Bahamian range have been lacking. During this study I examined 480 specimens from 41 cays and islands representing nine major island groups on the Great Bahama Bank, including the Bimini Islands, the Berry Islands, Andros Island, New Providence Island, Eleuthera Island, Cat Island, the Exuma Cays, Long Island, and the Ragged Islands.

I am grateful to the following curators and institutions (identified throughout by the abbreviations in parentheses) for permission to examine species of *Ameiva auberi* in their care: Charles M. Bogert and Richard G. Zweifel, American Museum of Natural History (AMNH); Edmond V. Malnate, Academy of Natural Sciences, Philadelphia (ANSP); Albert Schwartz, Miami, Florida (ASFS); Walter Auffenberg, Florida State Museum (UF); and Doris M. Cochran and James A. Peters, United States National Museum (USNM). Specimens in the collections of Carnegie Museum are designated by the abbreviation CM. My special thanks are due Wayne King, George B. Rabb, Neil D. Richmond, and Albert Schwartz for permission to use unpublished field notes on Bahamian *Ameiva,* and to Richmond, Schwartz, and M. Graham Netting for helpful criticism of the manuscript.

GAZETTEER OF LOCALITIES

The confusing multiplicity of names available for the innumerable cays and islands of the Bahamas has caused some difficulty in interpreting locality data in museum catalogues and in the published literature. The following alphabetical gazetteer includes the names of all cays and islands of the Great Bahama Bank from which specimens of *Ameiva auberi* have been examined. The larger island groups are labeled on the accompanying map (Fig. 1), and reference to the map and this gazetteer should permit general location of all islands mentioned in the systematic accounts. More detailed maps and charts, from which the place names here used were taken, are available in Kline (1964) and on U.S. Coast and Geodetic Survey chart 1002, "Straits of Florida."

ANDROS ISLAND (23° 43′ - 25° 11′ N., 77° 30′ - 78° 28′ W.) — A very large island, approximately 110 miles long, north to south, by a maximum of 45 miles wide, lying in the western arm of the Great Bahama Bank. Andros is crossed just south of center by three tidal passages, North Bight, Middle Bight, and South Bight, which divide this part of the island into a complex system of smaller cays.

BELL ISLAND (24° 19′ N., 76° 32′ W.) — A small circular cay between Halls Pond Cay and Cambridge Cay in the northern third of the Exuma Cays.

BITTER GUANA CAY (24° 08′ N., 76° 23′ W.) — A small elongate cay just off the north end of Great Guana Cay in the middle of the Exuma Cays chain.

BOND'S CAY (25° 29′ N., 77° 42′ W.) — A long cay near the southeastern corner of the Berry Islands.

CAT ISLAND (24° 07′ - 24° 44′ N., 75° 15′ - 75° 46′ W.) — A relatively large, long island in an isolated position between Eleuthera Island and San Salvador Island, near the eastern edge of the northern Bahamas.

CAVE CAY (23° 50′ N., 76° 14′ W.) — A small cay between Big Farmers Cay and Darby Island, north of Great Exuma Island in the Exuma Cays chain.

CHUB CAY (25° 24′ N., 77° 50′ W.) — The western portion of the largest cay in the southwestern segment of the Berry Islands, barely separated from Frazer's Hog Cay by Frazer's Creek.

CISTERN CAY (26° 46′ N., 77° 52′ W.) — A small island closely adjacent to the western side of Great Harbour Cay, in the northern Berry Islands.

CROOKED ISLAND (22° 40′ - 22° 50′ N., 74° 02′ - 74° 21′ W.) — A large island in the southern Bahamas, across the Crooked Island Passage from Long Island.

DEVIL'S CAY (25° 36′ N., 77° 42′ W.) — A small rectangular cay between Holmes Cay and Little Harbour Cay, near the center of the arc of the Berry Islands.

EAST BIMINI ISLAND (25° 24′ N., 79° 15′ W.) — Easternmost of the three main islands in the Bimini Island group, at the northwestern tip of the Great Bahama Bank.

EASTER CAY (25° 24′ N., 79° 15′ W.) — The recurved tip of North Bimini Island which lies adjacent to East Bimini Island, Bimini Island group.

ELEUTHERA ISLAND (24° 37′ - 25° 35′ N., 76° 08′ - 76° 47′ W.) — A very long crescent-shaped island north of Cat Island and east of New Providence Island, at the northern tip of the east arm of the Great Bahama Bank.

ELIZABETH ISLAND (23° 31′ N., 75° 42′ W.) — A small cay that forms part of the outer bar of Elizabeth Harbour, Great Exuma Island.

FLAMINGO CAY (22° 53′ N., 75° 51′ W.) — A relatively high and well-wooded small cay near the northern end of the Ragged Island chain.

FRAZER'S HOG CAY (25° 24′ N., 77° 50′ W.) — The eastern tip of the largest island in the southern part of the Berry Island group, barely separated from Chub Cay by Frazer's Creek.

GIBSON CAY (24° 18′ N., 77° 39′ W.) — A small cay in the mouth of the Middle Bight, east side of Andros Island.

GREAT EXUMA ISLAND (23° 28′ - 23° 48′ N., 75° 41′ - 76° 02′ W.) — Largest of the Exuma Cays, at the southern tip of the chain.

GREAT GUANA CAY (24° 09′ N., 76° 20′ W.) — A very long, narrow cay, one of the largest of the Exuma Cays, near the middle of the chain.

GREAT RAGGED ISLAND (22° 12′ N., 75° 43′ W.) — Largest cay in the Ragged Island group, at the extreme southern tip of the Great Bahama Bank.

GREEN CAY (24° 02′ N., 77° 11′ W.) — A small cay isolated on a westward extension of the east arm of the Great Bahama Bank, approximately midway between the southern part of Andros Island and the center of the Exuma Cays chain.

GUN CAY (25° 35′ N., 79° 19′ W.) — A small cay in the Bimini Island group, south of the main islands.

HOG CAY (22° 15′ N., 75° 44′ W.) — A small cay across the harbor from Great Ragged Island, in the Ragged Island Group.

HOG ISLAND (25° 06′ N., 77° 20′ W.) — An elongate small cay that lies parallel to the northeast shore of New Providence Island, opposite Nassau harbor. Sometimes called Paradise Island.

LITTLE EXUMA ISLAND (23° 27′ N., 75° 37′ W.) — A relatively large cay adjacent to the southern end of Great Exuma Island, at the southern tip of Exuma Cays chain. This island is frequently shown connected to Great Exuma (which it is not), and is not separately named on many charts.

LITTLE HARBOUR CAY (25° 34′ N., 77° 42′ W.) — A fair-sized cay between Devil's Cay and Frozen Cay in the center of the Berry Islands.

LITTLE RAGGED ISLAND (22° 10′ N., 75° 42′ W.) — A small uninhabited cay which lies very close to the south end of Great Ragged Island, at the southern end of the Ragged Islands.

LITTLE SAN SALVADOR ISLAND (24° 40′ N., 75° 55′ W.) — A small island in the channel between Eleuthera Island and Cat Island.

LONG ISLAND (22° 50′ - 23° 42′ N., 74° 49′ - 75° 21′ W.) — A very long and narrow island south of the Exuma Cays chain, on the southeastern corner of the Great Bahama Bank.

MANGROVE CAY (24° 15′ N., 77° 37′ W.) — A large triangular island that separates the South Bight from the Middle Bight of Andros Island at their eastern ends.

NEW PROVIDENCE ISLAND (25° 03′ N., 77° 15′ - 77° 34′ W.) — A fairly large, oval island at the northern tip of the eastern arm of the Great Bahama Bank, between Andros Island and Eleuthera Island.

NORTH BIMINI ISLAND (25° 44′ N., 79° 18′ W.) — The westernmost of the three main islands in the Bimini Island group.

NURSE CAY (22° 29′ N., 75° 50′ W. — A small cay north of Great Ragged Island, near the middle of the Ragged Island chain.

RACCOON CAY (22° 21′ N., 75° 49′ W.) — A small cay between Nurse Cay and Hog Cay, in the southern third of the Ragged Island chain.

REID'S CAY (24° 18′ N., 77° 54′ W.) — A small cay centered in the North Bight of Andros Island.

ROSE ISLAND (25° 06′ N., 77° 13′ W.) — An elongate cay in the series between the eastern tip of New Providence Island and the northwest point of Eleuthera Island.

SAMPSON CAY (24° 15′ N., 76° 29′ W.) — A small cay between Thomas Cay and Bitter Guana Cay, in the central part of the Exuma Cays chain.

SHIP CHANNEL CAY (24° 49′ N., 76° 49′ W.) — A long cay near the northern end of the Exuma Cays chain.

SOUTH BIMINI ISLAND (25° 42′ N., 79° 18′ W.) — Southernmost of the three largest islands in the Bimini Island group.

SOUTH CAT CAY (25° 32′ N., 79° 18′ W.) — A small cay south of Gun Cay, at the southern end of the Bimini Island group.

WARDERICK WELLS CAY (24° 23′ N., 76° 37′ W.) — A small cay between Halls Pond Cay and Hawksbill Cay in the northern third of the Exuma Cays chain.

CHARACTERS STUDIED

In analyzing geographic variation in Bahamian populations of *Ameiva auberi* I have used a combination of characters, including scutellation, color pattern, and size differences. Four standard scale counts selected for analysis were: (1) number of dorsal granules counted in a line around midbody (GAB); (2) total number of femoral pores; (3) number of scales in the fifteenth complete caudal verticil; (4) total number of subdigital scales on the fourth toes of both hind feet. Summaries of these data including mean values, ranges of variation, standard errors of the means, and sample sizes, in the eight Bahamian subspecies are presented in Table 2. In Tables 3 through 6 scutellation data for the eight subspecies are compared. In these latter tables a "+" symbol at the intersection of vertical and horizontal lines for two subspecies being compared denotes a statistically significant difference, based on nonoverlap of the ranges described by two standard errors on either side of the mean counts for the character in the two forms. A "—" indicates overlap of these ranges, and consequently the probable absence of a significant difference. The four characters of scutellation vary discordantly, and geographically adjacent races are frequently distinguished by significant differences in two or more characters.

MIDBODY GRANULES (GAB)

Northern populations from the Bimini Islands, Berry Islands, and Andros Island have the lowest GAB counts, but are not significantly different from each other. The populations of New Providence Island, Eleuthera Island, Cat Island, the Exuma Cays, and Long Island have significantly higher GAB counts, and form a second overlapping group without internal differentiation. The Ragged Island population has GAB counts that overlap those of the northern populations. (Tables 2 and 3).

FEMORAL PORES

The populations of the Bimini Islands and Berry Islands have similar average femoral pore counts, at the upper limit of the range observed in Bahamian populations of *A. auberi*. The Andros Island sample has significantly lower femoral pore counts, but overlaps the New Providence and Eleuthera populations in this character. Ship Channel Cay and Cat

Island share counts significantly higher than the New Providence and Eleuthera group, and overlap the Bimini-Berry group. There is a sharp separation between the Ship Channel Cay population and more southerly forms, which are united by much lower femoral pore counts. (Tables 2 and 4).

FIFTEENTH CAUDAL VERTICIL SCALES

The Bimini Islands and Berry Islands populations are similar in this character, and trenchantly differentiated from the Andros population which has a much lower mean count. The New Providence, Eleuthera, Cat Island, and Ship Channel Cay samples share overlapping counts at the upper limit for Bahamian populations. There is a sharp discontinuity, partially bridged by the Long Island population, between the Ship Channel Cay population and the remainder of the Exuma Cay samples. Ragged Island lizards have even lower numbers of scales in the fifteenth caudal whorl, overlapping only the population of Andros Island in this character. (Tables 2 and 5).

FOURTH TOE SUBDIGITALS

Counts of subdigitals in lizards from the Bimini and Berry Islands populations are similar, and among the lowest found in the Bahamian races of *A. auberi*. The Andros Island population counts are only slightly, but significantly, higher than those of the northern populations. New Providence, Eleuthera, and Cat Island samples share even higher counts, significantly different from the Andros sample. The Ship Channel Cay population is differentiated from geographically adjacent populations in this character, but overlaps the Andros and Ragged Island populations. Counts are slightly higher in the southern Exuma Cays and Long Island populations, and lower in the Ragged Islands lizards. (Tables 2 and 6).

COLOR PATTERN

The basic dorsal pattern of Bahamian *Ameiva auberi*, common to hatchlings and juveniles of all subspecies, consists of a series of five narrow, light, longitudinal stripes separated by darker fields three or four times wider than the stripes. Geographic variation in color pattern is expressed in the relative completeness of the stripes and their persistence through ontogeny, and in the color of the intervening fields.

The middorsal stripe is continuous from the parietal scales to the base of the tail but never appears on the free part of the tail. At maximum development the middorsal stripe passes forward between the orbits, where it is intensified and bordered by black marks, producing a brilliant black-yellow-black mark on the parietals. In some populations

the middorsal stripe persists throughout life; in others it fades and the entire area between the dorsolateral stripes becomes unicolor. The paired dorsolateral stripes may origininate on the supraciliaries, above the ear openings, or farther back on the sides of the neck. They may persist throughout life or fade at adulthood, but are always more persistent than the middorsal stripe. The lateral stripe is variable in width, and sharply defines the lower edge of the dorsolateral field above, but may be either sharp-edged below or gradually blended with the color of the lower sides.

The dorsal fields, between the middorsal stripe and the dorsolateral stripes, are gray, brown, or reddish, with or without dark edges outlining the adjacent stripes. The dorsolateral fields are usually black at hatching, although in some populations they are light-centered, or even spotted with lighter colors. In some populations old individuals gradually resorb the black pigment, producing at first an emarginate field, then a punctate field, and eventually destroying the black field entirely. The dorsolateral field frequently extends onto the tail as a black stripe. The lateral field, below the lateral stripe, is usually diffuse and poorly defined, but in one population it is intensely black and relatively sharp-edged.

Adult males of nearly all Bahamian populations exhibit extensive blackening of the throat, mesoptychium, chest, and undersides of the forelegs. The extent of the black ventral pigmentation is geographically variable, and often serves to differentiate adjacent subspecies. Sexual dimorphism in color pattern is further expressed in the potential for ontogenetic pattern changes. Females are usually much smaller than males (Table 1), and retain juvenile elements of the pattern into adulthood. The ontogenetic pattern modifications produced by the loss of stripes and changes in the color of the fields not only start earlier in males, but progress much further in the adult males. Females of all populations tend to retain the juvenile pattern with relatively little ontogenetic modification.

TABLE 1

MAXIMUM SIZE IN BAHAMIAN *Ameiva auberi*

Subspecies	Total Examined	Largest ♂	Largest ♀
richmondi	69	116.6	80.4
multilineata	54	119.7	71.3
kingi	32	99.4	72.2
thoracica	123	116.4	76.0
felis	46	97.0	61.7
focalis	22	109.0	83.0
obsoleta	83	107.0	70.9
bilateralis	42	87.0	75.0

Finally, size has been used as a character differentiating some Bahamian subspecies of *Ameiva auberi*. Absolute size differences are difficult to quantify and interpret, but in populations from which adequate samples are available, differences in the potential size attained by adults are obvious. The maximum sizes, snout-vent length (SVL), observed in males and females of the various subspecies are listed in Table 1. Adult females are remarkably smaller than adult males in all Bahamian populations of *Ameiva auberi*.

SYSTEMATIC REVIEW

Ameiva auberi thoracica Cope

Ameiva thoracica Cope, 1862, Proc. Acad. Nat. Sci. Philadelphia, 14:64.
Ameiva auberi thoracica, Hecht, 1954, Year Book Amer. Phil. Soc., (1954): 133-135.

HOLOTYPE: ANSP 9158, an adult male, from New Providence Island, Bahama Islands, collected by Dr. H. C. Wood, Jr.

DIAGNOSIS: A Bahamian subspecies of *Ameiva auberi* characterized by a combination of large size (males to 116 mm., females to 74 mm. SVL), high number of dorsal granules at midbody, moderate number of femoral pores, very high number of scales in the fifteenth caudal verticil, and high number of fourth-toe subdigital scales; middorsal stripe barely persistent, dorsolateral stripes continuous to supraciliaries, dorsal fields olive, dorsolateral fields black and becoming emarginate with age; throat, mesoptychium, and two-thirds of ventrals black, chinshields white (adult males).

SPECIMENS EXAMINED: New Providence Island: ANSP 9149-9180 (holotype and paratypes); AMNH 76284-76288 + 6 untagged, CM 20379, Nassau; AMNH 76279-76283 + 11 untagged, near Nassau Village; ASFS 10640-10641, 2.8 mi. W Oakes Field; UF 14686, Mermaid Pool; ASFS 6960, V10319-V10324, V10343-V10348, Yamacraw Beach. Hog Island: CM 20434, across from Nassau (New Providence Island). Rose Island: AMNH 76255-76258. Eleuthera Island (localities arranged from north to south): ASFS 17215, 6.2 mi. NW Gregory Town; ASFS 17216-17217, 1.4 mi. NW Gregory Town; AMNH 69226-69228, Hatchet Bay; ASFS 17464-17465, 17470-17482, Hatchet Bay Plantation; ASFS 17414, 17510, Alice Town; ASFS 17463, ocean side, opposite Alice Town; ASFS 17123-17135, 3 mi. NW James Cistern; ASFS 17566, 6.3 mi. SE James Cistern; USNM 31992, The Bluff; ASFS V6827, approx. 4 mi. NNW Rock Sound; ASFS V6824-V6826, Southeast Point. Little San Salvador Island: MCZ 39645, Salt Pond Cay.

DISTRIBUTION: New Providence and Eleuthera islands and connecting cays, and Little San Salvador Island, Bahama Islands.

REDESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 114 mm., tail 267 mm. (tip missing); dorsal granules at midbody (GAB) 112; femoral pores 14 and 14 (total 28); 32 scales in the fifteenth caudal verticil; fourth-toe subdigital scales 40 and 42 (total 82). The dorsal ground color has faded to a uniform light gray, and the middorsal stripe is only faintly visible on the neck and anterior part of the back. The head is also a faded gray color dorsally. Dorsolateral light stripes extend from the temporal

areas to the groin. The dorsolateral black fields are broad and ragged-edged, but solid black centrally and continuous from just behind the ears, well onto the posterior half of the tail. The areas immediately below these black fields are a slightly lighter gray, and definite light stripes extend from these light areas to the ears. Below the lateral light stripes and above the ventrals the gray ground color is stippled with black pigment. The dorsal surfaces of the fore- and hindlegs are uniform light gray. Ventrally the chinshields, throat, chest, under sides of the forelegs, and central ventrals to the pre-anal scales are black. Scales on the lateral, posterior, and anterior surfaces of the thighs are black with lighter centers, and the underside of the tail is dark The holotype is slightly soft, somewhat faded, and has the ventral body wall cut free as an anterior flap. Otherwise, the specimen is in good condition.

Inexplicably Barbour and Loveridge (1929) wrote that the types of *Ameiva thoracica* Cope were not to be found, either in the Museum of Comparative Zoology or the Academy of Natural Sciences of Philadelphia. The series ANSP 9149-9180 unquestionably represents the syntypes of *A. thoracica,* and ANSP 9158, which most closely approximates the measurements and data given by Cope, is identified as the holotype.

VARIATION: See tables. The type series from New Providence Island (ANSP 9149-9180) has the following counts: GAB 103-120 (110.6 ± .77); femoral pores 24-34 (27.3 ± .41); fifteenth caudal verticil scales 29-37 (32.2 ± .28); fourth-toe subdigitals 74-94 (82.3 ± .72).

Ameiva auberi thoracica is a strongly lineate subspecies. In hatchlings and subadults the middorsal stripe is continuous to the frontoparietals, and somewhat intensified and black-edged on the head. The dorsolateral stripes extend forward to the light-edged supraciliaries, and the lateral stripes are continuous to the ear openings. The middorsal stripe may be lost in the largest males, but persists in smaller males and all females. The dorsolateral and lateral stripes persist throughout life in all individuals. The dorsal fields, reddish brown in hatchlings, gradually fade to light brown or olive in older animals. The dorsolateral fields are intensely black and sharp-edged in all except the oldest males, in which they usually become emarginate or even reduced to a row of spots through loss of the black pigment. The black dorsolateral fields have vague brick-red to dull tan edges in life. The lateral stripes, pale cream to gray in life, usually retain sharp lower edges throughout ontogeny.

The ventral black coloration of adult males first appears at a snout-vent length of approximately 60 mm. (ASFS V10347) and gradually extends and intensifies until the throat, mesoptychium, chest, frequently the under sides of the forelegs, and most of the ventrals are solid glossy black. On the ventrals, however, black pigment is confined to the central four or six rows of scales, and the outer ventral scale rows are spotted and mottled with bluish pigment. The chinshields are almost always white, in striking contrast to the intense black of the throat granules.

In the largest males (AMNH 76281, 105 mm. SVL) the chinshields are also blackened along the inner edges.

Hatchlings have reddish brown dorsal fields, a tan-to-yellowish middorsal stripe, pale cream or yellow dorsolateral stripes, and a grayish green tail.

The series from Eleuthera Island has the folowing scale counts: GAB 99-129 (109.8 ± .16); femoral pores 23-30 (26.6 ± .31); fifteenth caudal verticil scales 28-34 (31.2 ± .24); fourth-toe subdigitals 74-93 (81.2 ± .66). Despite the significant difference in mean number of fifteenth caudal verticil scales, and some subtle differences in color pattern, the Eleuthera Island sample (which consists mostly of hatchlings and juveniles) is referred to *thoracica*. Elements of the color pattern shared by Eleuthera and New Providence populations are the distinct and anteriorly extensive stripes, the reddish-brown dorsal and black dorsolateral fields, and the striped interparietal and supraciliaries. In contrast to New Providence lizards, Eleuthera individuals show early loss of the middorsal stripe (ASFS V6824, male, 76 mm. SVL), less extensive black ventral coloration in adult males, extreme reduction and eventual loss of the black pigment in the dorsolateral fields (USNM 31992), and blue rather than green tails as hatchlings. Nevertheless, in view of the divergence of adjacent populations on Andros Island, Cat Island, and Ship Channel Cay, internal variation of *thoracica* seems relatively insignificant.

Evidence from populations inhabiting the islets and cays connecting New Providence and Eleuthera, which could illuminate the relationships of the end populations, is inconclusive. Four specimens from Rose Island (AMNH 76255-76258) have characters common to both populations, although the adult male (92 mm. SVL) has reduced throat color suggestive of Eleuthera males.

A single specimen from Little San Salvador Island (MCZ 39645) is referred to *thoracica*, rather than to the subspecies of nearby Cat Island, on the basis of the unmarked solid black dorsolateral fields and a middorsal stripe continuous onto the parietals.

COMPARISIONS: Although *Ameiva auberi thoracica* includes a relatively large range of variation, the subspecies has adequate internal agreement when compared with adjacent races. The population of Andros Island has significantly fewer dorsal granules, fifteenth caudal verticil scales, and fourth-toe subdigital scales. These populations share elements of the color pattern, but the rich bronze-red dorsal fields of Andros Island lizards is not matched by *thoracica*. To the east there are similarly

trenchant differences between *thoracica* and the Cat Island subspecies. Cat Island lizards have higher GAB counts, more femoral pores and are probably significantly smaller as adults. In addition, the dorsolateral fields of *thoracica* are solid black or emarginate rather than internally spotted as in the Cat Island population. Some of the differences between New Providence *thoracica* and the Cat Island population may be partially bridged by adequate samples of adult lizards from Eleuthera Island.

Ameiva auberi thoracica finds its closest relative in the population of Ship Channel Cay, which is almost surrounded on the north by the range of *thoracica*. There are significant differences here in femoral pores and fourth-toe subdigital scales, but size and other characters of scalation are similar. Although the color patterns are grossly alike there are substantial differences in the extent of the ventral coloration in males, in the color of the snout, and in the tendency to lose dorsal striping.

Ameiva auberi felis, new subspecies

HOLOTYPE: CM 20440, an adult male, from The Bight, Cat Island, Bahama Islands, taken on June 14, 1941, by George R. Campbell.

PARATYPES: All from Cat Island (localities arranged from north to south), as follows: ASFS V2174, Orange Creek, December 1, 1963, D. R. Paulson; AMNH 76267-76273 + 13 untagged, Bennett's Harbour, March 24, 1963, Van Voast Expedition; ASFS V2161-V2163, V2237-V2238, Tea Bay, Nov. 30, 1963, D. R. Paulson; AMNH 76266, Tea Bay Settlement, March 21, 1953, Van Voast Expedition; ASFS V2113-V2117, hills above The Bight, Nov. 28, 1963, D. R. Paulson; AMNH 76259-76265, McQueens, 1-2 mi. E of the village, Jan. 24, 1953, Van Voast Expedition; ASFS V11116, 0.5 mi. N Port Howe, Nov. 2, 1966, native collector.

DIAGNOSIS: A Bahamian subspecies of *Ameiva auberi* characterized by a combination of moderate size (males to 97 mm., females to 62 mm. SVL), high number of dorsal granules at midbody, high number of femoral pores, moderate number of scales in the fifteenth caudal verticil, and high number of fourth-toe subdigital scales; dorsal stripes becoming obsolete with age, dorsal fields olive-gray, dorso-lateral fields black spotted with lighter color; throat, mesoptychium, and anterior few rows of ventrals black in adult males.

DISTRIBUTION: Cat Island, Bahama Islands.

DESCRIPTION OF THE HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 72.3 mm., tail incomplete; dorsal granules at midbody 109; femoral pores 13 and 13 (total 26); 30 scales in the fifteenth caudal verticil; fourth-toe subdigital scales 39 and 40 (total 79). Dorsal ground color dark olive, middorsal and dorsolateral stripes completely absent. Dorsolateral black fields continuous from above forelegs to groin, and punctuate with numerous, almost confluent light spots, producing a distinctly reticulate appearance. Lateral light stripe medium gray, sharp-edged above and below, and bordered below by a dark gray field shading into the dark ventrals. Dorsal surfaces of limbs

olive. Central part of throat, mesoptychium, and anterior three rows of ventrals black, the black extending to the under surfaces of the forelegs as black stippling on dark gray. Lateralmost few rows of ventrals light-spotted, remainder of ventral surface dark gray, probably as a result of overexposure to strong formalin. The holotype appears to be generally darkened by improper preservation.

VARIATION: See tables. The presence of reddish spots in the dark-brown-to-black dorsolateral fields of *felis* is unique among Bahamian races of *Ameiva auberi*. These spots are visible in hatchlings, and may grow and coalesce with adjacent spots and with the border of the dorsolateral field to form a ragged or even reticulate field in older individuals. The majority of animals exhibit distinctly spotted dorsolateral fields. The middorsal stripe is tan-orange to tan, continuous onto the interparietal in post-hatchlings (ASFS V2117, 42 mm. SVL), but completely obliterated by the brown-to-medium-brown dorsal fields in the largest males. The dorsolateral stripes are also tan-orange in life and more persistent than the middorsal stripe. In even the smallest individuals examined the dorsolateral stripes end above the foreleg insertions. The lateral stripes are wide and buffy in life, and bordered below by lateral fields of purplish blue. The lateral fields may be irregularly spotted, giving a checkered appearance to the lower sides. The ventral color in life is pinkish blue or slightly purplish marked with black in adult males. The black ventral markings first appear at approximately 55 mm. SVL as a black smudge in the center of the throat, a black mesoptychium, and blackening of the anterior few rows of chest scales. Fully developed, the black covers most of the throat (but usually not the chinshields), the mesoptychium and under sides of the forelegs, and the anterior third of the ventral scales. The tail is bright blue to blue-green in life, and several hatchlings retain a bright cerulean, but distinctly striped, tail in preservative.

COMPARISONS. *Ameiva auberi felis* stands alone among the Bahamian races of *auberi* in the presence of light-spotting in the dorsolateral fields. From the adjacent population of the Exuma Cays *felis* is strongly divergent in all characters of scalation, and probably has closest affinity with the Eleuthera Island population of *thoracica*. Eleuthera Island *thoracica* and *felis* have a tendency toward ontogenetic loss of the middorsal stripe, similar GAB counts, fifteenth caudal verticil scale counts, and fourth-toe subdigital scale counts. They are distinguished by a significant difference in femoral-pore counts, and by the completely different color of the dorsolateral fields, which early in life fade into zones of black spots in Eleuthera Island *thoracica*.

Ameiva auberi kingi, new subspecies

HOLOTYPE: CM 40915, an adult male, from Gibson Cay, in the mouth of South Bight, Andros Island, Bahama Islands, taken on July 4, 1965, by Neil D. Richmond.

PARATYPES: CM 40916-40920, same data as holotype.

ASSOCIATED SPECIMENS: All from Andros Island (localities arranged from north to south) as follows: UF 5982, 17923-17924, approx. 9 mi. at 240° from Stafford Creek Settlement; ASFS 10287-10293, Fresh Creek; UF 17927-17930, Andros Town; UF 17920-17921, east tip of Reid's Cay, North Bight; MCZ 42008, Mangrove Cay; MCZ 42003, south side of South Bight; UF 17931-17933, 2 mi. at 55° from mouth of Deep Creek; MCZ 42006-42007, Cistern Creek.

DIAGNOSIS: A Bahamian subspecies of *Ameiva auberi* characterized by a combination of moderate size (males to 99 mm., females to 72 mm. SVL), low number of dorsal granules at midbody, moderate numbers of femoral pores and fourth-toe subdigital scales, and very low number of scales in the fifteenth caudal verticil; middorsal stripe persistent in adults, dorsal fields reddish brown, dorsolateral fields black; chinshields, throat, mesoptychium, and anterior fourth of ventrals black in adult males.

DISTRIBUTION: Andros Island, Bahama Islands.

DESCRIPTION OF HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 99.4 mm., tail 258 mm. (complete); dorsal granules at midbody 97; femoral pores 13 and 13 (total 26); 27 scales in the fifteenth caudal verticil; fourth-toe subdigital scales 36 and 37 (total 73). Dorsal fields a rich, reddish brown, shading to medium brown on top of the head and tail. Middorsal stripe gray, extending from the frontoparietal almost to the middle of the back. Dorsolateral light stripes intense, extending from the temporal regions to near the groin. Dorsolateral black fields vivid and sharp-edged, bearing narrow stripes of lighter color adjacent to the bordering light stripes. Lateral light stripes broad, subtended by lines of irregular black spots above the ends of the ventrals. Chinshields, throat, chest, under sides of forelegs, and approximately a quarter of the anterior ventrals black. Posterior ventrals bluish laterally shading to white at mid-venter; pre-anal scales, under surfaces of thighs, and lower side of tail very light gray with white mottling. Tail brown above, with black and white stripes, light gray below. Dorsal surfaces of limbs gray-brown, stippled with black.

VARIATION: See tables. The type series from Gibson Cay (CM 40915-40920) has the following counts: GAB 88-103 (average 96.8); femoral pores 22-26 (24.2); fifteenth caudal verticil scales 27-31 (28.3); fourth-toe subdigital scales 73-77 (74.7).

Ameiva auberi kingi is characterized by reddish brown, almost bronze, dorsal fields in combination with solid black dorsolateral fields. The middorsal stripe is buff to yellowish in life, and continuous anteriorly beyond the parietal scales where it is bordered by black marks on each side, forming a distinctive black-white-black mark on the head of preserved specimens. The dorsolateral stripes are continuous from the canthals, over the supraciliaries (also yellow), to the base of the tail. The stripes become intensely yellow near the groin. The black dorso-

lateral fields are edged with brown to brick-red stripes in life, and the dorsal fields have dark edges in hatchlings. The venter is dirty white to gray, and adult males have intense black ventral markings which cover the chinshields, throat, mesoptychium, under sides of the forelegs, and a few anterior rows of ventrals. The greatest extent of ventral blackening is exhibited by a male from Gibson Cay (CM 40918, 87 mm. SVL) that has the anterior four ventral rows, as well as the centers of the next three rows, entirely blackened.

The series of specimens from Fresh Creek (ASFS 10287-10293) shows several distinct differences in color pattern from the Gibson Cay sample. In the Fresh Creek series the vivid white middorsal stripe is broadly edged with black, from the parietals to about the midpoint of the back. In the smaller specimens (*ca.* 50-60 mm. SVL) the dorsal fields are light-centered and black-edged. The dorsolateral fields, however, are solid black, without evidence of light centers. These seven specimens average 104.9 dorsal granules at midbody (95-115); 27.3 femoral pores (25-32); 28.4 scales in the fifteenth caudal verticil (26-30); and 80.4 fourth-toe subdigital scales (74-89).

The huge land mass of Andros Island is largely unexplored herpetologically. Available samples of *Ameiva auberi* from Andros are inadequate for analysis of intra-island variation, but there are suggestions that representative series from all parts of the island may reveal the presence of more than one recognizable race.

COMPARISONS: *Ameiva auberi kingi* occupies a position of intermediacy in scale counts between *thoracica* and the populations of the Berry and Bimini Islands to the north. In GAB counts, *kingi*, with the Berry and Bimini Island populations, forms a compact group distinct from all other Bahamian races of *Ameiva auberi*. Femoral pore counts, on the other hand, align *kingi* closely with the *thoracica-felis* group. In fifteenth caudal verticil and fourth-toe subdigital scale counts *kingi* is significantly different from the geographically adjacent populations, and in both these characters, overlaps the Ragged Islands population far to the south.

The color pattern of *kingi* shows a strong resemblance to *thoracica* in the development of the stripes anteriorly on the parietals, frontals, and supraciliaries. The general tendency for intensification of the middorsal stripe on the head reaches a maximum in the Fresh Creek population of *kingi*. The combination of solid black dorsolateral fields and reddish brown dorsal fields distinguishes *kingi* not only from *thoracica*, but from all other Bahamian populations of *Ameiva auberi* as well. Further points of difference between *kingi* and geographically adjacent populations are

found in the development of the black ventral coloration in adult males. The extent of blackening of the ventral scales is much less in *kingi* than in *thoracica,* but *kingi,* unlike *thoracica,* has black chinshields. The combination of divergent scale counts with the reddish dorsal and black dorsolateral fields makes *kingi* one of the most distinctive Bahamian races of *Ameiva auberi.*

Ameiva auberi multilineata, new subspecies

HOLOTYPE: CM 41196, an adult male, from Bond's Cay, Berry Islands, Bahama Islands, taken July 26, 1965, by Neil D. Richmond.

PARATYPES: CM 41195, 41197-41199, same data as holotype.

ASSOCIATED SPECIMENS: All from the Berry Islands, as follows: Cistern Cay: CM 41201-41205. Devil's Cay: AMNH 76299-76303 + 3 untagged. Frazer's Hog Cay: AMNH 76289-76293 + 15 untagged, ASFS V10665-V10666. Little Harbour Cay: AMNH 76294-76298. Chub Cay: ASFS V10649-V10656.

DIAGNOSIS: A Bahamian subspecies of *Ameiva auberi* characterized by a combination of very large size (males to 120 mm., females to 71 mm. SVL), low number of dorsal granules at midbody, fairly high number of femoral pores, moderate number of scales in the fifteenth caudal verticil, and very low number of fourth-toe subdigital scales; all dorsal stripes persistent and continuous onto the head, lateral stripes sharp-edged and distinct, dorsal and dorsolateral fields light reddish brown with dark edges; chinshields, throat, mesoptychium, and most of the central ventrals black in adult males.

DISTRIBUTION: The Berry Island group, Bahama Islands. Definitely known from Bond's Cay, Chub Cay, Cistern Cay, Devil's Cay, Frazer's Hog Cay, and Little Harbour Cay.

DESCRIPTION OF THE HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 97.6 mm., tail 237 mm. (complete); dorsal granules at midbody (GAB) 105; femoral pores 15 and 14 (total 29); 31 scales in the fifteenth caudal verticil; fourth-toe subdigital scales 36 and 40 (total 76). Dorsal ground color reddish brown, top of head gray. Middorsal stripe distinct and sharp-edged from the interparietal almost to the sacrum, edged with dark brown. Dorsal fields light-centered, the dark brown edges bordering the adjacent stripes. Dorsolateral stripes bright gray-white, continuous from the supraciliaries onto the tail, and broadly and sharply edged on both upper and lower sides with dark brown. Dorsolateral field light red-brown centrally, dark brown to black at the edges. Lateral stripe sharp-edged above and below, distinctly lighter than the ventrolateral field, continuous to the ear. Sides below the lateral stripes gray, shading into the black ventrals. Chinshields, throat, mesoptychium, under sides of forelegs, chest, and almost all ventrals (both central and lateral) black. Lateralmost few rows of ventrals spotted with blue. Under sides of thighs and pre-anal scales light gray mottled with dark gray, and spotted with blue. Under side of tail grayish white. Dorsal surfaces of limbs brown, mottled with dark gray or black.

VARIATION: See tables. The type series from Bond's Cay (CM 41195-41199) has the following counts: GAB 97-107 (average 104.2); femoral pores 27-31 (29.0); fifteenth caudal verticil scales 28-31 (28.9); fourth-toe subdigital scales 72-77 (75.2).

The most distinctive feature of *Ameiva auberi multilineata,* as the name implies, is the many-lined appearance of adults. This effect is produced in part by the persistence of the dorsal light stripes, and in part by the dark borders located in the edges of the light dorsal fields. In life the dorsal and dorsolateral fields are brick-red to red-brown in the centers, and dark brown at the edges. Even in hatchlings (CM 41160, 37.7 mm. SVL), the light centers of the dorsolateral fields are apparent. The middorsal stripe in *multilineata* is unusually vivid, about twice the width of the dorsolateral stripes, and distinctly grayish rather than yellow. The lateral stripe is pale gray, and the lower sides are slightly darker gray. Black ventral coloration appears in males at about 65 mm. SVL, and eventually involves the chinshields, throat, mesoptychium, chest, under sides of the forelegs, and part of the ventrals. In the very largest males more than half of the ventrals are blackened, but the outermost rows of ventrals remain dark gray with bluish spots and mottling.

The short series of specimens from Little Harbour Cay (AMNH 76294-76298) shows a tendency toward development of light-spotting in the dorsolateral fields, and to some extent in the dorsal fields. The spots give a dilute or faded appearance to the dorsal pattern of the adult female, and in a lesser degree to that of the adult males. The stripes are persistent and black-edged, however, and other details of color pattern are normal for the subspecies.

A series of magnificent specimens from Devil's Cay (AMNH 76299-76303 + 3 untagged) includes three males between 110 and 120 mm. SVL — the largest Bahamian *Ameiva* known. In these gigantic specimens the dorsal and dorsolateral fields are faded to a uniform light brown, and the middorsal stipe is visible only on the anterior half of the body. The most striking aspect of the pattern of these animals is the vivid yellow, black-edged dorsolateral stripes diagnostic of *multilineata.* The black ventral coloration involves slightly more than half of the ventrals in these largest males.

COMPARISONS: *Ameiva auberi multilineata* is the largest Bahamian race, approached in size only by the Bimini Island subspecies and by *thoracica.* The Bimini Island population and *multilineata* share scale-count characters that differentiate them from all other Bahamian races of *Ameiva auberi.* In GAB counts, *multilineata* and the Bimini population overlap only with *kingi;* their fifteenth caudal verticil scale counts distinguish them from *kingi, thoracica,* and *felis* but not from other races; and in fourth-toe subdigital counts they differ significantly from all other Bahamian subspecies of *auberi.* Femoral pore counts separate *multilineata* from all races except *felis.*

The northernmost two subspecies of *Ameiva auberi, multilineata* and the Bimini Island subspecies, share a significant number of features of color pattern and scutellation and are strongly differentiated from all other Bahamian races. The subtle characters that serve to distinguish these two populations from each other are outlined in the following discussion of the Bimini Island subspecies. The reddish brown dorsal fields of these northern populations separate them from all Bahamian races except *kingi,* and the light-centered, dark-edged dorsolateral fields are found only in this northern group. The persistence of the dorsal striping is unmatched in any other subspecies, and the reduction of ventral blackening in adult males distinguishes the northern pair of races from adjacent forms. Together, these two populations form a unit sharply divergent from all other Bahamian races of *Ameiva auberi,* not only in color pattern but also in size and scutellation.

Ameiva auberi richmondi, new subspecies

HOLOTYPE: CM 34140, an adult male, from near Lyons, North Bimini Island, Bahama Islands, taken March 15, 1956, by M. Graham Netting and Neil D. Richmond.

PARATYPES: All from North Bimini Island, as follows: CM 34139, 34141-34145, same data as holotype; CM 32589, Mosquito Point, March 23, 1954, M. G. Netting and N. D. Richmond; CM 34112-34114, between Lyons and Lerner Marine Laboratory, March 10, 1956, M. G. Netting and N. D. Richmond; CM 34130, Lerner Marine Laboratory, March 12, 1956, M. G. Netting and N. D. Richmond; UF 16591-16597, Paradise Point, April 19, 1960, W. King; ASFS V11603, between Alicetown and Paradise Point, March 6, 1967, Richard Thomas; UF 16598-16601, Alicetown, April 18, 1960, W. King.

ASSOCIATED SPECIMENS: All from the Bimini Islands, as follows: East Bimini Island: CM 34182-34185, extreme southern tip. Easter Cay: CM 34171-34172. Gun Cay: UF 17934-17941. South Bimini Island: AMNH 68745-68749 + 7 untagged, ASFS X4784, CM 32556, 34116, 34131-34132, west end; CM 32558-32559, 32580-32581, Black Land; CM 34127-34128, 33180, Water Tower; ASFS X4689, western side; UF 22421, 2 mi. S Alicetown (North Bimini Island) at 141°. South Cat Cay: CM 34163-34164.

DIAGNOSIS: A Bahamian subspecies of *Ameiva auberi* characterized by a combination of large size (males to 117 mm., females to 80 mm., SVL), low number of dorsal granules at midbody, very high number of femoral pores, moderate number of scales in the fifteenth caudal verticil, and very low number of fourth-toe subdigital scales; dorsal stripes persistent but black edging eventually lost, lateral stripe not well-defined, dorsal and dorsolateral fields light-centered (reddish brown to tan); throat, mesoptychium, chest, and first four or five ventral rows black in adult males.

DISTRIBUTION: The Bimini Island group, Bahama Islands. Definitely known from East Bimini Island, Easter Cay, Gun Cay, North Bimini Island, South Bimini Island, and South Cat Cay.

DESCRIPTION OF THE HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 91.1 mm., tail 178 mm. (regenerated); dorsal granules at midbody (GAB) 108; femoral pores 15 and 15 (total 30); 30 scales in the fifteenth caudal verticil; fourth-toe subdigital scales 37 and 37 (total 74). Dorsal ground color medium reddish brown, head slightly lighter and more yellowish. Middorsal stripe light gray, continuous from interparietal almost to sacrum, not noticeably dark-edged. Dorsolateral light stripes from temporal areas to groin, light gray and distinct, and edged on the anterior half of the body with black flecking both above and below. Dorsolateral fields reddish brown, lighter than the dorsal fields, with concentrations of black stippling along the upper and lower edges anteriorly. Lateral stripe light gray, dark-edged above and sharp but fading into a dark gray area below and above the ventrals. Dorsal surfaces of limbs medium brown. Inner half of chinshields, throat, chest, and approximately one-third of anterior central ventrals black. Posterior central ventrals blue-gray, spotted with white; lateral ventrals dark gray, spotted with blue. Under sides of thighs gray-blue, spotted with white and pre-anal scales white. Tail indistinctly striped, brown above and gray below.

VARIATION: See tables. The type series from North Bimini Island has the following counts: GAB 91-108 ($99.8 \pm .89$); femoral pores 28-34 ($30.0 \pm .36$); fifteenth caudal verticil scales 28-31 ($29.6 \pm .22$); fourth-toe subdigitals 68-75 ($71.7 \pm .40$).

Ameiva auberi richmondi is another strongly lineate race from the northwestern corner of the Great Bahama Bank. Hatchlings of *richmondi* have vivid cream dorsal and dorsolateral stripes, usually somewhat expanded but never black-edged on the head. The stripes remain brilliant cream to yellow in subadults and adult females but are considerably diluted and reduced to paler yellow or yellow-gray in adult males. In adults the dorsolateral stripes are continuous only onto the neck, and the lateral stripes to the forelegs. The dorsal and dorsolateral fields are black or dark brown at the edges in hatchlings, the former with broad red-brown central fields, the latter with very narrow lighter centers. As the lizards grow, the light central zones of the dark fields enlarge and eventually obliterate the dark edges. The dorsal field becomes completely light long before the dorsolateral field is unicolor. The lateral stripe is cream to gray, sharp-edged above, but blending gradually into the darker color below.

In an adult male paratype from North Bimini Island (ASFS V11603, 98 mm. SVL), the middorsal stripe is light gray and visible from the posterior edge of the parietal scales almost to the sacrum. The light gray dorsolateral stripes originate in the temporal areas and extend nearly to the groin. The dorsal and dorsolateral fields are almost exactly the same shade of light brown, and their black edges persist only as scattered melanophores along the edges of the dorsolateral stripes. The lateral stripes, and the sides below, are uniform light gray.

The tail of hatchlings is bright blue; that of adults is gray above, and white marked with bluish mottling below, and is not black-striped along the side.

Suffusion of the gular area with black pigment begins at an early age in *richmondi,* and all males over 65 mm. SVL have extensively blackened throats and mesoptychia. The usual maximum extent of the black includes the throat, mesoptychium, chest, under sides of the forelegs, and approximately one-third to one-half of the anterior ventrals. The lateral ventrals are blue-spotted, and the pre-anal and thigh scales are dirty white. In a common variant type, represented in series from East Bimini Island, South Bimini Island, and Easter Cay, the black of the ventral scales is restricted to the first two or three transverse rows. The remainder of the ventrals is white, mottled with light gray.

In virtually all aspects of color and scutellation, the populations of the various islands and cays of the Bimini Islands form a close-knit and relatively invariable group.

COMPARISONS: The close similarity of *Ameiva auberi richmondi* with *multilineata* and their trenchant differences from the other Bahamian races of *Ameiva auberi* have been mentioned. It remains only to point out the characters that differentiate these two subspecies of the northwestern arm of the Great Bahama Bank. These races are almost identical in all counts except femoral pore scales, which are significantly more numerous in *richmondi.* Here, admittedly, the difference is small, but it is based on large samples from each island group, and the standard errors of the mean values are reassuringly small. Size is another distinguishing characteristics of these races. Male *richmondi* attain a maximum snout-vent length of 117 mm., but they do not compare in bulk to the 120 mm. males of *multilineata.*

There are several subtle, but constant characters of color pattern that distinguish *richmondi* from *multilineata.* Paramount among these is the early loss, in *richmondi,* of the black edges of the dorsolateral fields, producing uniform-colored rather than the dark-edged fields of *multilineata.* In *richmondi* the dorsal stripes of adults are less extensive anteriorly, and the lateral stripe less well defined, in comparison with *multilineata.* Finally, the ventral black pattern of male *richmondi* rarely includes the chinshields, which are always dark in *multilineata.*

In sum, the subspecies *richmondi* and *multilineata* are remarkably similar and obviously share a common ancestry. Nevertheless, there are constant characters of both color and scutellation that can be used to differentiate them. Furthermore, their relative isolation from one another

at opposite ends of the northwestern arm of the Great Bahama Bank leads me to regard their subtle but consistent differences as adequate evidence of subspecific divergence.

Ameiva auberi focalis, new subspecies

HOLOTYPE: CM 41147, an adult male, from Ship Channel Cay, Exuma Cays, Bahama Islands, taken on July 23, 1965, by Neil D. Richmond.

PARATYPES: All from Ship Channel Cay, as follows: CM 41139-41146, same data as holotype; ASFS V10718-V10730, taken on July 6, 1966, by J. B. Brown, A. Schwartz, and R. Thomas.

DIAGNOSIS: A Bahamian subspecies of *Ameiva auberi* characterized by a combination of fairly large size (males to 107 mm., females to 83 mm. SVL), very high number of dorsal granules at midbody, moderate number of femoral pores and fifteenth caudal verticil scales, and low number of fourth-toe subdigital scales; middorsal stripe lost in adults, dorsal fields olive, dorsolateral fields black, chinshields and throat blue, black ventral markings reduced to a bar in the center of the mesoptychium and another on the anterior two or three rows of ventrals, snout pink.

DISTRIBUTION: Known only from the type locality, Ship Channel Cay, but possibly occurs on several of the northernmost Exuma Cays, Bahama Islands.

DESCRIPTION OF THE HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 110.3 mm., tail *ca.* 239 mm (complete); dorsal granules at midbody 112; femoral pores 14 and 14 (total 28); 30 scales in the fifteenth caudal verticil; fourth-toe subdigital scales 37 (one toe missing). Dorsal ground color, top of head and dorsal sides of limbs olive gray. Middorsal stripe faintly indicated as a lighter gray area. Dorsolateral light stripes also faint and only feebly lighter than the ground color. Dorsolateral dark fields slightly emarginate, but vivid black and continuous from the foreleg insertions to the groins. Below the dorsolateral black fields are slightly lighter gray areas, blending into the gray-blue ventral color. None of the stripes extends onto the neck, which is entirely unlined, shading gradually from the ventral blue-gray to the dorsal olive gray. Mental scale, rostral scale, and anterior upper and lower labials lighter than other head scales. Entire ventral surface from chinshields to pre-anals light gray-blue, with a small patch of black scales on the mesoptychium and black stippling on the anterior two transverse rows of ventral scales. Central posterior ventrals, femoral-pore-scale rows, and under side of tail white with blue-gray smudging. Tail weakly but distinctly striped laterally, olive-gray dorsally.

VARIATION (See tables): *Ameiva auberi focalis* is unique among the Bahamian races of the species in the extreme reduction of the black ventral coloration of adult males. The maximum development consists of a black bar across the mesoptychium, a second bar on the anterior two and one-half rows of ventral scales, and a speckling of black throat granules. The under sides of the forelegs, chinshields, and throat are never solid black. The entire ventral surface is usually gray-blue in males, white in females. Adult males occasionally lack any trace of the usual black ventral pigmentation (CM 41146).

The middorsal stripe is pale lemon-yellow in life, continuous from the frontal scale to the sacrum in the smallest specimens examined (ASFS V10729-V10730, *ca.* 65 mm. SVL), but is not black-edged on the head. The middorsal stripe is persistent in adult females, but may be completely lost in large males (CM 41140, 107 mm. SVL). The dorsal fields are olivaceous in life, and the dorsolateral stripes are tan to yellowish, vaguely continuous to the supraciliaries in small individuals. In old adults the dorsolateral stripes are conspicuously brighter than the middorsal stripe.

The intense black dorsolateral fields retain their consistency throughout life, or may be slightly invaded by their narrow brick-red edging. The lateral stripes and lateral fields are only poorly differentiated, greenish in life, and blend gradually with the blue-gray ventral color. The tail is gray above in adults, lighter than the olive dorsal fields, black-striped laterally, and gray-blue below the stripe, shading to white midventrally.

COMPARISONS: Although immediately distinguishable by the reduction of black ventral markings in adult males, *Ameiva auberi focalis* shares a combination of characters of the geographically adjacent subspecies. In scale counts *focalis* is not significantly different from *thoracica* in granules around midbody and fifteenth caudal verticil scales but has a significantly higher number of femoral pores and a significantly lower number of fourth-toe subdigital scales. From the populations farther south in the Exuma Cays chain, *focalis* is significantly different in both fifteenth caudal verticil scales and fourth-toe subdigital scales, differences which are, in both cases, partially bridged by the Long Island population. There is broad overlap with the southern populations in number of granules at midbody, but the number of femoral pores is significantly different. Thus *focalis* overlaps the range of variation of the adjacent population on the north in two characters and of the population on the south in three characters. *Ameiva auberi focalis* is distinguished from the adjacent subspecies on the north by two characters, and from the population on the south by one character.

Elements of the color pattern of *focalis* may also be traced to the neighboring populations. The pink nose and tendency for early loss of the middorsal stripe are shared with the populations in the Exuma Cays. Retention of the solid black dorsolateral fields throughout life, lack of a well-defined, conspicuously lighter lateral stripe, and olive rather than gray dorsal fields are characteristic of *Ameiva auberi thoracica.*

The cays immediately to the south of Ship Channel Cay along the

chain of the Exuma Cays have been poorly explored herpetologically. Scanty evidence suggests that there may be an actual hiatus in the range of *Ameiva auberi* between Ship Channel Cay and the northernmost island inhabited by the Exuma Cays subspecies (A. Schwartz, *in litt.*). The details of the distribution of *Ameiva auberi* in the northern Exuma Cays are in need of investigation to clarify the exact range of *focalis* and the relationship of *focalis* to the Exuma Cays subspecies.

Ameiva auberi obsoleta, new subspecies

HOLOTYPE: CM 43976 (formerly ASFS V10805), an adult male, from Adderley's, Long Island, Bahama Islands, taken on October 12, 1966, by Richard Thomas.

PARATYPES: All from Long Island (localities arranged from north to south) as follows: ASFS V8598, Cape Santa Maria, January 24, 1964, C. R. Warren; ASFS V10806-V10810, Adderley's, October 12, 1964, Richard Thomas, ASFS V10868, same locality and collector, October 14, 1966; ANSP 24169, MCZ 42309-42314, Simms, 1936, R. McLean; ASFS V8553, Grays Settlement, January 27, 1965, C. R. Warren, ASFS V8594-V8597, same locality and collector, January 23-30, 1965; ASFS V10827-V10829, 4.9 mi. SE Clarence Town, October 13, 1966, Richard Thomas; ASFS V10830-V10834, 2.8 mi. SW Mortimers, October 13, 1966, Richard Thomas.

ASSOCIATED SPECIMENS: All from the Exuma Cays (localities arranged from north to south) as follows: Warderick Wells Cay: AMNH 76244-76249. Bell Island: AMNH 76254. Sampson Cay: CM 41101-41103, 41117. Bitter Guana Cay: AMNH 76252-76253, CM 41070. Great Guana Cay: CM 41055-41057, 41060-41062, 41064-41066. Cave Cay: CM 41023-41025, 41040-41045. Great Exuma Island: ASFS V6993-V7000, 5.4 mi. SE Rolleville; ASFS V10795-V10797, 9 mi. NW George Town. Elizabeth Cay: ASFS V7100. Little Exuma Island: ASFS V7044, V7093, 5.7 mi. SE The Ferry; ASFS V10794, 1 mi. ESE Forbes Hill; ASFS V10792-V10793, *ca.* 2 mi. SE Forbes Hill; ASFS V10768-V10773, *ca.* 0.5 km. W Williams Town.

DISTRIBUTION: The southern Exuma Cays and Long Island, Bahama Islands. Definitely known from Warderick Wells Cay, Bell Island, Sampson Cay, Bitter Guana Cay, Great Guana Cay, Cave Cay, Great Exuma Island, Elizabeth Cay, and Little Exuma Island, all in the Exuma Cays group, and from several localities on Long Island. The specimens reported from Crooked Island (Cochran, 1934) belong with this subspecies (see below).

DESCRIPTION OF THE HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 86.6 mm., tail 225 mm. (complete); dorsal granules at midbody (GAB) 103; femoral pores 13 and 13 (total 26); 32 scales in the fifteenth caudal verticil; fourth-toe subdigital scales 40 and 40 (total 80). Dorsal ground color and top of head medium gray-brown, middorsal stripe faded. Dorsolateral light stripes narrow but bright, extending from the forelegs to the tail. Dorsolaterial fields intensely black, slightly emarginate. Lateral light stripes dirty gray-white, sharp-edged both above and below. Ventrolateral fields black with a series of large, discrete, light spots. Dorsal surfaces of limbs dark brown. Chinshields, throat, under side of forearms, chest, and two-thirds of central ventrals black. Posterior third of central ventrals off-white smudged with gray. Lateral

ventrals tessellated (light blue on black). Pre-anal scales, under sides of thighs, and under sides of tail dirty white. Dorsal surface of distinctly striped tail gray-brown. Middorsal field brown to tan, dorsolateral stripes buff, lateral stripes pale gray to buff, and tip of snout orange in life (R. Thomas, field notes).

VARIATION (See tables): The type series from Long Island has the following counts: GAB 96-117 (107.07 ± 1.1) femoral pores 22-30 ($25.7 \pm .37$); fifteenth caudal-verticil scales 27-33 ($30.5 \pm .30$); fourth-toe subdigital scales 72-90 (83.6 ± 1.1).

The most striking and immediately obvious characteristic found in all populations of *Ameiva auberi obsoleta* is the early loss of the middorsal stripe and eventual fading of all lineate parts of the dorsal pattern. In the Long Island series the middorsal stripe is only faintly visible in the smallest specimen (ASFS V8598, 40 mm. SVL) and is completely obliterated in all larger individuals. The resulting broad middorsal zone between the dorsolateral stripes is light brown to gray. The faint buff dorsolateral stripes are continuous from the forelegs to the sacrum even in large specimens. The intense black dorsolateral fields are emarginate in very old specimens, but retain their integrity in the type series. The lateral stripe is light gray, and the dark gray field below it is light-spotted.

The black ventral coloration of males appears at an early age. One 68-mm. male has the chest, throat, mesoptychium, and even the under sides of the forelegs densely blackened. In older individuals the black also covers the chinshields. Unique characteristics of *obsoleta* are the pointed posterior margin of the black patch on the ventrals, and the brilliantly tessellated light-blue-on-dark-blue pattern of the lateral ventral scales. The tail is bright blue in hatchlings, and vividly striped in all adults.

Despite its extensive geographic range northward through the Exuma Cays chain to Warderick Wells Cay, *obsoleta* is relatively invariable in color-pattern characteristics. Samples from the northern Exuma Cays exhibit tendencies toward longer retention of the middorsal stripe, and more brilliant striping. For example, the middorsal stripe is faintly visible in large males from Sampson Cay (CM 41102, 90 mm. SVL, and CM 41117, 95 mm. SVL). In general, the specimens from Sampson Cay are more brilliantly striped than animals from the Long Island population. Persistent stripes also appear in the series from Warderick Wells Cay (AMNH 76244-76249) and in a single specimen from Bitter Guana Cay (CM 41070). The general tendency of *obsoleta* toward reduction of the striped pattern reaches its ultimate expression in a series of specimens from Cave Cay (CM 41023-41025, 41040-41045). In the smallest

animals of this series, males between 65 and 75 mm. SVL, the dorsal field is a uniform gray-brown, the dorsolateral stripes are faintly visible above solid, but emarginate, black dorsolateral fields, and the lateral stripes appear as vague lighter gray areas above the ventrals. In males there is progressive reduction of all stripes and fields, culminating in a virtually uniform gray-brown dorsum separated from the lighter gray sides by a line of black stippling representing the dorsolateral field. The appearance is that of a nearly unicolor lizard. Similiar patterns, resulting from extreme reduction of the dorsolateral fields, are found in occasional specimens of *Ameiva auberi thoracica* from Eleuthera Island, and rarely in the populations of the northern Ragged Islands (Cochran, 1934).

In addition to the variable reduction of the dorsal pattern in *obsoleta*, there are several constant features of the pattern which also obtain throughout the range of the subspecies. The most important of these is the ventral pattern of adult males. The combination of the reduced black patch on the ventrals, in the shape of a posteriorly pointed V, with the brilliant light and dark blue tessellation of the lateral ventrals, occurs in all populations. A second constant character of *obsoleta* is the presence of a contrastingly colored snout, either noticeably lighter, or of a hue different from that of the sides of the head. In specimens from Long Island the snout is orange in life; in Warderick Wells Cay and Cave Cay animals it is pink in life, and in the specimens from Sampson Cay, it was light gray in life.

Scale-count data were analyzed separately for each island in the Exuma Cays chain in an attempt to detect clinal variation along this extensive archipelago, but no significant clinal pattern was found.

It is appropriate to mention at this point the published record of *Ameiva thoracica (=auberi)* from Crooked Island, across the Crooked Island passage from Long Island (Cochran, 1934). I have examined the two specimens on which this record is based, USNM 81497 and 81498, collected by Dr. Paul Bartsch in 1930. These adult males have 106 and 110 dorsal granules at midbody, 23 and 25 femoral pores, 30 scales (each) in the fifteenth caudal verticil, and 72 and 79 fourth-toe subdigital scales. In almost all elements of the color pattern they are identical with males of comparable size from Long Island, a notable exception being the faint but distinct middorsal stripe of both individuals. Because of the virtual meristic identity of these two specimens with *Ameiva auberi obsoleta* from Long Island, and in view of the failure of recent expeditions to find a population of *Ameiva auberi* on Crooked Island, I am dubious of the validity of the Bartsch record. Of course there is a pos-

sibility that a natural population of *auberi* occurs on Crooked Island, but it requires verification.

COMPARISONS: *Ameiva auberi obsoleta* occupies a central position geographically on the Great Bahama Bank, and in many apects of color and scutellation *obsoleta* is central to the other Bahamian races of *Ameiva auberi*. The basic color pattern of olive-to-gray dorsal fields and black dorsolateral fields separated by cream-to-yellow stripes is repeated in the Ragged Island population to the south, and in *focalis, thoracica,* and other more northerly populations. *Obsoleta* differs from both *focalis* and *thoracica* in the early obsolescence of the striping and the unique ventral pattern of adult males, and from *felis* in the unspotted dorsolateral black fields. From the populations of the Ragged Islands, *obsoleta* may be distinguished by its tessellated lateral ventrals, less discrete lateral stripes, and spotted lateral fields. Moreover, the Ragged Island lizards generally have a persistant middorsal stripe and more brownish dorsal fields.

In scale counts *obsoleta* finds close similiarity with *focalis* and *thoracica* to the north. *Obsoleta* is distinct from the northern populations in femoral pores, and overlaps in the other three scale-count characters examined. From the adjacent Ragged Islands subspecies, *obsoleta* is distinguished by significant differences in mean numbers of dorsal granules at midbody, fifteenth caudal verticil scales, and fourth-toe subdigital scales. Finally, size is a useful character in differentiating *obsoleta* from geographically adjacent races of *Ameiva auberi. Obsoleta,* with size maxima of 107 mm. and 71 mm. in males and females respectively, is smaller than *focalis* (109 mm. and 80 mm.) and larger than the Ragged Island subspecies (87 mm. and 75 mm.).

Ameiva auberi bilateralis, new subspecies

HOLOTYPE: CM 40985, an adult male, from the south end of Great Ragged Island, Bahama Islands, taken July 10, 1965, by Neil D. Richmond.

PARATYPES: All from Great Ragged Island, as follows: CM 40984, 40988-40995, ASFS V11363-V11364, same data as holotype; CM 40955-40959, Gun Point, July 9, 1965, Neil D. Richmond.

ASSOCIATED SPECIMENS: All from the Ragged Islands, as follows: Little Ragged Island: CM 40982. Hog Cay: CM 40943-40945. Raccoon Cay: USNM 81475. Nurse Cay: CM 40922-40937. Flamingo Cay: USNM 81451-81454.

DIAGNOSIS: A Bahamian subspecies of *Ameiva auberi* characterized by a combination of small size (males to 87 mm., females to 75 mm. SVL), moderate number of dorsal granules at midbody, very low number of femoral pores, low number of scales in the fifteenth caudal verticil, and moderate number of fourth-toe subdigital scales; middorsal stripe usually persistent, dorsal fields brown, dorsolateral fields black and sharp-edged, lateral stripe clear white, broad and vivid, with a

black lateral field below and above the ends of the ventrals; throat, chinshields, mesoptychium, and anterior half of ventrals black in adult males.

DISTRIBUTION: The Ragged Island group, Bahama Islands. Definitely known from Raccoon Cay, Nurse Cay, Great Ragged Island, Little Ragged Island, Flamingo Cay, and Hog Cay.

DESCRIPTION OF THE HOLOTYPE: An adult male with the following measurements and counts: snout-vent length 87 mm., tail 174 mm. (complete); dorsal granules at midbody 100; femoral pores 13 and 13 (total 26); 29 scales in the fifteenth caudal verticil; fourth-toe subdigital scales 37 and 37 (total 74). Dorsal ground color and top of head light brown, middorsal stripe visible as a faint trace posterior to neck. Dorsolateral stripes whitish, narrow, not black-edged above. Dorsolateral fields sharp-edged, solid black, continuous from above forelegs onto tail. Lateral stripes dead white, well-defined and sharp-edged, almost as wide as dorsolateral fields. A second black field below each lateral stripe, the two separated by the broad white lateral stripe. All stripes continuous only from foreleg insertion; none starts on head. Chinshields, throat, chest, mesoptychium, under sides of forelegs, and almost half of central ventrals black. Posterior central ventrals smudged with gray, lateral ventrals bluish smudged with black. Under sides of thighs light gray spotted with bluish, dorsal sides of limbs dark brown stippled with black. Tail brown above, with a strong black lateral stripe enclosed in vivid white stripes. Under side of tail gray.

VARIATION (See tables): The type series from Great Ragged Island (CM 40955-40959, 40984-40985, 40988-40995, ASFS V11363-V11364) has the following counts: GAB 97-116 (104.5 ± 1.0); femoral pores 20-27 ($24.1 \pm .27$); fifteenth caudal verticil scales 26-32 ($28.9 \pm .22$); fourth-toe subdigital scales 71-82 ($76.3 \pm .53$).

Ameiva auberi bilateralis is characterized by the broad, sharp-edged and very white lateral stripes, bordered by intense black dorsolateral and lateral fields. Hatchlings (CM 40994-40995, *ca.* 32 mm. SVL) have a brilliantly striped pattern, including a broad middorsal stripe continuous from neck to tail, slightly narrower dorsolateral stripes originating on the neck, and lateral stripes fully as wide and bright as the middorsal stripe. In adult females the dorsolateral and lateral stripes retain their brilliance, unlike the faded middorsal stripe. The middorsal stripe of adult males is also faded, but remains visible as a gray area in the brownish dorsal fields even in the largest individuals. The dorsolateral fields are intense black in individuals of both sexes and all ages. Old males have slightly emarginate dorsolateral fields. An exception is seen in males from Flamingo Cay (USNM 81451-81454), which have the black fields reduced to a line of spots, and other lineate elements of the pattern faded.

The black ventral coloration of males is well developed in individuals as small as 60 mm. SVL (CM 40927) and ultimately extends to cover the chinshields, throat, mesoptychium, and a small triangular area of

anterior ventrals. The remainder of the central ventrals is frequently smudged with black in larger males, and the lateral ventrals are dark blue, with faint suggestions of a tessellated pattern.

The series from Nurse Cay (CM 40922-40937) presents several differences from the Great Ragged Island sample. Nurse Cay lizards have a greater tendency toward loss of the middorsal stripe, and a less pronounced lateral light stripe. The dorsolateral black field of the adult males is considerably reduced, as in the Flamingo Cay population. Adult males from Nurse Cay have extensive blackening of the anterior half of the central ventrals.

Ameiva auberi bilateralis is probably the smallest of the Bahamian races, smaller even than the diminutive *felis*. Although less than 40 specimens were examined from throughout the range of *bilateralis*, the samples contained many adults and a good representation of all size classes. The largest male examined was only 87 mm. snout to vent, and the largest female 75 mm. snout to vent.

COMPARISONS: *Bilateralis* is very similar to the adjacent subspecies *obsoleta* in many features of color pattern, but is distinguished from *obsoleta*, indeed from all other Bahamian subspecies of *Ameiva auberi*, by the brilliant white lateral stripes and development of unmarked black fields below the lateral stripes. Other color characteristics that distinguish *bilateralis* from *obsoleta* are the lack of a boldly tessellated pattern on the lateral ventrals, and a tendency toward longer retention of the striped elements of the pattern. Despite the similarities in the color patterns of *obsoleta* and *bilateralis*, these subspecies are strongly differentiated in scutellation. *Bilateralis* is significantly different from *obsoleta* in dorsal granules at midbody, fifteenth caudal verticil scales, and fourth-toe subdigital scales, and overlaps the range of *obsoleta* only in femoral-pore-scale counts. *Bilateralis* occupies a unique position among the southern Bahamian races. Rather than continuing the generally gradual clinal reduction in all scale counts, which obtains from New Providence through Long Island, *bilateralis* has sharply lower counts which overlap only the populations of Andros Island and the Berry Island and Bimini Island groups in the northern Bahamas. *Bilateralis* is distinguished from these northern populations by many characters of the color pattern and by size.

THE GREEN CAY POPULATION

A small series of specimens of *Ameiva auberi* (CM 40171-40179) was taken on Green Cay on July 18, 1965, by Neil D. Richmond. These lizards constitute something of a zoogeographic enigma, since they resemble

most closely *Ameiva auberi bilateralis* rather than the geographically adjacent populations: *obsoleta* of the Exuma Cays chain and *kingi* of Andros Island.

The Green Cay lizards have a strongly lineate color pattern, with all dorsal stripes persistent throughout life. The middorsal stripe is continuous from the neck to the tail, the narrow dorsolateral stripes originate on the neck, and the lateral stripe is fairly sharp and white. The dorsal fields are gray-brown, the dorsolateral fields are black and emarginate in older adults. The lateral fields are dark gray, neither black as in *bilateralis* nor spotted as in *obsoleta*. Adult males have the chinshields, throat, mesoptychium, and anterior two or three rows of ventrals blackened, and the remaining central ventrals black-smudged. The lateral ventrals are light blue, the under sides of the thighs and tail are white to light gray. The tail is boldly striped.

In scutellation the Green Cay population is almost identical with *bilateralis* in dorsal granules at midbody, femoral pores, and fourth-toe subdigital scales, and has a slightly higher count of fifteenth caudal verticil scales. Of course the sample is too small to be statistically reliable, but meristically the Green Cay population is obviously very similar to, if not identical with, *bilateralis*. Until a larger sample is available it seems best to withhold formal assignment of the Green Cay population to one of the described subspecies. Nevertheless, the similarity of these lizards to *bilateralis* suggests that the population has been directly derived from the Ragged Islands.

DISCUSSION

The land reptile fauna of the Bahama Islands has been the subject of much discussion and speculation because, as a totally derivative fauna in a geologically recent archipelago, it promises to yield concrete data on basic problems such as the potential for overwater dispersal and the evolutionary rates of various species. The earlier literature on the relationships of the land biota of the Bahamas has been summarized by Rabb and Hayden (1957), who also presented a useful analysis of the complex and as yet incompletely understood geological history of the Bahamas. In a more recent contribution Schwartz (1968a) has elaborated on the faunistic relationships and history of the Bahamian amphibians and reptiles. Schwartz's scheme explains the present distribution and origins of the faunas, and helps to place *Ameiva auberi* in perspective with regard to the other reptile species of the Bahamas. Schwartz postulates early invasion of the Bahamas by Cuban and Hispaniolan faunas, subsequent extinction of this fauna over most of the

Great Bahama Bank with limited survival on peripheral and southern refuges, and the eventual re-invasion of the Great Bahama Bank in late Pleistocene times. The colonists of this second major wave have invaded the newly emergent lands and old refuges to varying extents. It is with this final group of immigrants that I associate the Bahamian populations of *Ameiva auberi.*

The pattern of distribution of *Ameiva auberi* on the Great Bahama Bank strongly suggests very recent arrival from Cuban sources. *Auberi* has managed to invade most of the central islands of the bank, but is restricted peripherally. Cat Island represents the maximum extent of eastward dispersal, and although the island lies on the edge of the Great Bank, it is only a short distance across a narrow water barrier from Eleuthera Island. *Auberi* has also reached the Bimini Islands. This might be regarded as an indication of a longer history in the archipelago, but *Ameiva auberi richmondi* of the Bimini Islands is extremely similar to *A. a. multilineata* of the adjacent Berry Islands, which suggests that *richmondi* may be newly arrived on the Biminis. Despite having reached the peripheral Cat Island and Bimini Islands, and isolated interior islands such as Green Cay and Flamingo Cay, the general distribution of *auberi* on the Great Bahama Bank bespeaks recency. *Auberi* has failed to extend its range to any of the more isolated large islands at the eastern periphery, such as Conception Island, Rum Cay, and San Salvador Island, and apparently has not crossed the Crooked Island Passage to the south (but see discussion under *A. a obsoleta,* above). Most significantly, *auberi* has crossed none of the relatively narrow water barriers between the northern islands of the Great Bahama Bank and the large islands of the Little Bahama Bank to the north.

The exact timing of the invasion, or invasions, of the Great Bahama Bank by Cuban *Ameiva auberi* is not clear. The only concrete evidence lies in the fossils of *Ameiva auberi* from New Providence Island reported by Etheridge (1966). These specimens, identical with recent species, came from cave deposits assigned to the pre-Pamlico portion of the Wisconsin glacial stage of the Pleistocene. Of the nineteen species of amphibians and reptiles that comprise the Great Bahama Bank herpetofauna, no less than thirteen have been successful in extending their ranges beyond the islands of the Great Bank proper. Seven species have invaded the Little Bahama Bank to the north, using the Great Bahama Bank as a stepping stone, and ten of the thirteen species have either reached eastern peripheral islands, or have crossed the Crooked Island Passage to the south. The remaining species include the proba-

bly old, Cat Island endemic turtle *Chrysemys felis,* and four species of lizards (including *Ameiva auberi*) regarded as conspecific with Cuban stocks. This fairly clear evidence of recent immigration to the Great Bahama Bank is somewhat clouded by the relatively great morphological radiation of the Bahamian *Ameiva auberi.* The total of eight subspecies of *auberi* here recognized far exceeds the number of recognizable geographic races in other species of the reptile fauna. By comparison *Leiocephalus carinatus,* which has a much larger geographic range, has evolved no more than four Bahamian races (Rabb, MS.). *Sphaerodactylus decoratus* has a distribution on the Great Bahama Bank very similar to that of *Ameiva auberi,* with the single exception that *decoratus* has reached Rum Cay. A modern revision of *decoratus* admits only three recognizable races on the Great Bahama Bank (Thomas and Schwartz, 1966), although it must be noted that *Sphaerodactylus* are the master mariners among lizards, and thus the Bahamian populations may be of exceedingly recent origin. Other Great Bank reptiles and amphibians follow this general pattern of relatively little fragmentation into geographic races. The eight races of *Ameiva auberi* have apparently evolved as isolates during the gradual and successive invasion of various parts of the Great Bahama Bank by over-water dispersal.

The obvious recency of immigration of *auberi* to the Bahamas, and the remarkable morphological radiation which has produced a constellation of well-marked subspecies, underscores the latent variability and evolutionary plasticity of this group of lizards. Both *Ameiva* and the related genus *Cnemidorphorus* contain many notoriously labile species. In topographically diverse land masses and in island archipelagoes this lability is expressed in the formation of numerous relatively divergent geographic races. The only comparable situation outside the family Teiidae of which I am aware is the explosive radiation of some species of the lacertid genus *Lacerta* on islands and archipelagoes in the Mediterranean Sea.

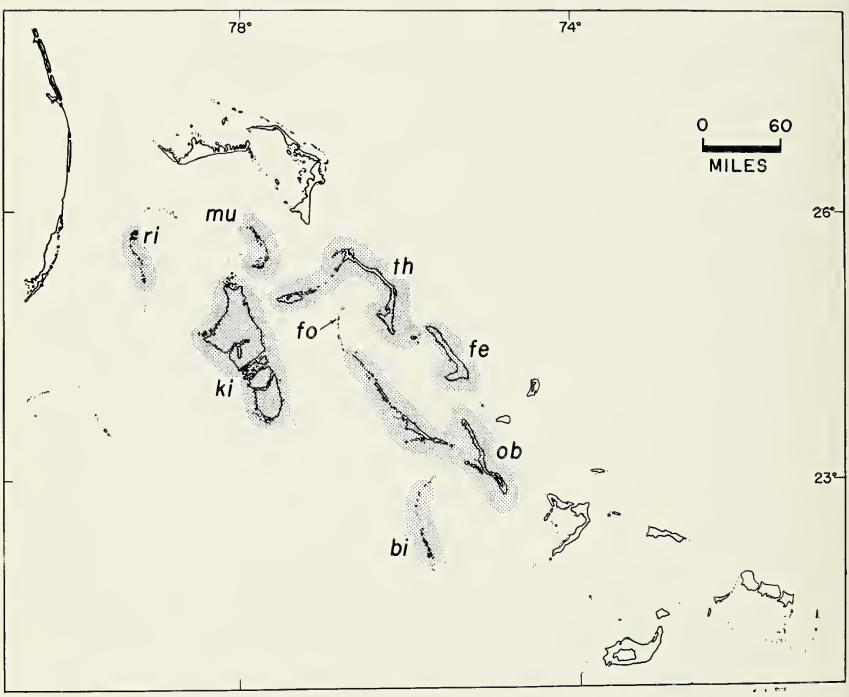


Fig. 1. Map of the Bahama Islands, showing distributions of the Bahamian subspecies of *Ameiva auberi,* as follows (north to south): ri — *richmondi* (Bimini Islands); mu — *multilineata* (Berry Islands); ki — *kingi* (Andros Island); th — *thoracica* (New Providence, Eleuthera, and Little San Salvador Islands); fe — *felis* (Cat Island); fo — *focalis* (Ship Channel Cay); ob — *obsoleta* (Exuma Cays from Warderick Wells Cay south, Long Island); bi — *bilateralis* (Ragged Islands).

TABLE 2

VARIATION IN SCALE COUNTS OF BAHAMIAN *Ameiva auberi*

	Midbody Granules (GAB)	Femoral Pores	15th Caudal Verticil	4th Toe Scales
richmondi	98.80± .60(89-108)N= 49	30.00±.23(26-35)N= 56	30.20±.18(27-33)N= 62	72.69±.36(68-79)N= 55
multilineata	100.70± .77(87-111)N= 52	28.70±.26(25-33)N= 50	30.52±.20(28-33)N= 52	72.90±.50(64-80)N= 52
kingi	99.87±1.25(86-115)N= 31	26.66±.39(22-32)N= 30	28.28±.29(26-32)N= 29	76.53±.83(64-89)N= 30
thoracica	109.15± .86(98-129)N=106	26.78±.29(23-30)N=111	31.59±.21(28-37)N=113	81.08±.55(71-94)N=109
felis	111.74± .92(100-124)N= 42	28.29±.30(25-32)N= 41	31.64±.23(29-34)N= 44	81.30±.60(74-92)N= 40
focalis	112.60±1.73(98-128)N= 22	28.96±.25(27-31)N= 22	31.23±.26(29-33)N= 22	76.65±.61(72-82)N= 20
obsoleta	107.69± .64(96-120)N= 75	25.04±.20(22-30)N= 81	30.01±.18(26-34)N= 82	79.60±.44(70-90)N= 73
bilateralis	103.60±1.0 (95-116)N= 27	24.10±.27(20-27)N= 35	28.74±.21(26-32)N= 38	75.94±.52(70-82)N= 36

TABLE 3

COMPARISON OF GAB COUNTS IN BAHAMIAN *Ameiva auberi*

			richmondi	*multilineata*	*kingi*	*thoracica*	*felis*	*focalis*	*obsoleta*	*bilateralis*
richmondi	49	98.8±1.2	X	—	—	+	+	+	+	+
multilineata	52	100.7±1.6		X	—	+	+	+	+	—
kingi	31	99.9±2.5			X	+	+	+	+	—
thoracica	106	109.2±1.8				X	—	—	—	+
felis	42	111.7±1.8					X	—	+	+
focalis	22	112.6±3.4						X	+	+
obsoleta	75	107.7±1.2							X	+
bilateralis	27	103.6±2.0								X

Subspecies arranged from north to south. For explanation of table see footnote, pages 116-117.

TABLE 4

COMPARISON OF FEMORAL PORE COUNTS IN BAHAMIAN *Ameiva auberi*

			richmondi	*multilineata*	*kingi*	*thoracica*	*felis*	*focalis*	*obsoleta*	*bilateralis*
richmondi	56	30.0±.40	X	+	+	+	+	+	+	+
multilineata	50	28.7±.50		X	+	+	—	—	+	+
kingi	30	26.7±.80			X	—	+	+	+	+
thoracica	111	26.8±.60				X	+	+	+	+
felis	41	28.3±.60					X	—	+	+
focalis	22	29.0±.50						X	+	+
obsoleta	81	25.0±.40							X	—
bilateralis	35	24.1±.60								X

Subspecies arranged from north to south. For explanation of table see footnote, pages 116-117.

TABLE 5

COMPARISON OF FIFTEENTH CAUDAL-VERTICIL SCALE COUNTS IN BAHAMIAN *Ameiva auberi*

			richmondi	*multilineata*	*kingi*	*thoracica*	*felis*	*focalis*	*obsoleta*	*bilateralis*
richmondi	62	30.2±.40	X	—	+	+	+	—	—	+
multilineata	52	30.5±.40		X	+	+	+	—	—	+
kingi	29	28.3±.60			X	+	+	—	+	—
thoracica	113	31.6±.40				X	—	—	+	+
felis	44	31.6±.40					X	—	+	+
focalis	22	31.2±.60						X	+	+
obsoleta	82	30.0±.40							X	+
bilateralis	38	28.7±.40								X

Subspecies arranged from north to south. For explanation of table see footnote, pages 116-117.

TABLE 6

COMPARISON OF FOURTH-TOE SUBDIGITAL SCALE COUNTS IN BAHAMIAN *Ameiva auberi*

			richmondi	*multilineata*	*kingi*	*thoracica*	*felis*	*focalis*	*obsoleta*	*bilateralis*
richmondi	55	72.7±.80	X	—	+	+	+	+	+	+
multilineata	52	72.9±1.0		X	+	+	+	+	+	+
kingi	30	76.5±1.6			X	+	+	—	+	—
thoracica	109	81.1±1.2				X	—	+	—	+
felis	40	81.3±1.2					X	+	—	+
focalis	20	76.7±1.2						X	+	—
obsoleta	73	79.6±.80							X	+
bilateralis	36	75.9±1.0								X

Subspecies arranged from north to south. For explanation of table see footnote, pages 116-117.

III. DISCUSSION

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With the description of 24 Cuban subspecies and eight Bahamian subspecies of *Ameiva auberi* Cocteau, the species has now been shown to be extremely polytypic and genetically plastic. Such diversity may be surprising to some readers, but actually it is to be expected. The geographically correlated variation of the three Hispaniolan species (*Ameiva chrysolaema*, *A. taeniura*, and *A. lineolata*), whose study proceded the present one on *A. auberi*, has served in a way as a precedent. The study of the Hispaniolan species indicated that on at least one of the Greater Antilles the genus *Ameiva* has differentiated on the subspecific level in response to edaphic and geographical isolating factors. Although Cuba does not present the topographic and physiographic diversity of Hispaniola, it is nonetheless far from a flat, featureless and topographically uniform plain over which *Ameiva auberi* is neatly and evenly distributed. The response of some Cuban reptiles (notably *Anolis equestris* in Oriente Province; Schwartz, 1964b) to often-dramatic ecological differences and geographical isolating features, by the development of distinct subspecies, is well known. Considering also that: Cuba is an elongate island (about 1200 kilometers long with a maximum width of from 35 to 200 kilometers); there are several extensive chains of cays associated both with it and the Isla de Pinos; Cuba varies ecologically, from extremely arid coasts to mesic forested mountainous highlands with elevations to 2005 meters (Pico Turquino); and that there are many ranges and massifs with lesser but still respectable heights and areas, it is not surprising that *Ameiva auberi* varies greatly in several characters in a geographically correlated manner. As far as variation in the Bahamian archipelago is concerned, this too is expected, consid-

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ering both the plasticity of *A. auberi* on Cuba and the (at least presently) completely disjunct nature of many of the Great Bank islands that are inhabited by the species.

Apparently the closest relative of *A. auberi* is *A. dorsalis* Gray from Jamaica. In Barbour and Noble's revision of *Ameiva* (1915:425), *dorsalis, thoracica,* and *auberi* are keyed out together. Examination of specimens of *A. dorsalis* shows that the Jamaican species has many resemblances to *A. auberi* insofar as scutellation is concerned. Both have 10 transverse rows of ventral scales and comparable numbers of longitudinal rows of ventral and fourth-toe subdigital scales. There are, however, trenchantly different features of scutellation in *A. dorsalis* (greater number of femoral pores, much smaller dorsal granules, much less enlarged preantebrachials, differences in scutellation of the temporal region) which I regard as being of specific rather than subspecific value. Thus, *A. dorsalis* is to be regarded as a species distinct from *A. auberi.* That *dorsalis* is related to *auberi* is attested by the gross similarity of dorsal pattern (a median dorsal pale longitudinal area, pointed anteriorly, which gradually expands as it progresses posteriorly to embrace the base of the tail) to that of some of the eastern Cuban subspecies of *A. auberi,* namely *sabulicolor* and *granti.* Such resemblances may well be fortuitous, but on the other hand no other West Indian *Ameiva* has this type of median dorsal marking. The proximity of Jamaica to the southern Oriente coast (about 150 kilometers) seems to reinforce these resemblances as indicators of relationship.

Barbour and Noble (1915:422), in their schema representing the relationships of the West Indian and continental species of *Ameiva,* suggested that *auberi* and *dorsalis* were distantly and independently derived from *A. undulata* of Middle America, that *thoracica* is closely related to *auberi,* and that *dorsalis* is directly related to *A. chrysolaema* of Hispaniola. At the moment I do not agree with this latter relationship. Certainly *dorsalis* is much more closely related to *auberi* than to *chrysolaema.* Barbour and Noble also suggested that *A. taeniura* (=*A. lineolata sensu* Barbour and Noble) is a distant relative of *auberi.* This relationship seems more plausible, although it is now generally accepted (Cochran, 1941:273-274) that *taeniura* is more closely related to *A. polops* of St. Croix, and thence to *A. maynardi* in the southeastern Bahamas and *A. wetmorei* in Puerto Rico. These three species have the dorsal caudal scales with oblique keels, although this character is least definitely shown in *taeniura.*

It seems likely that *dorsalis-auberi* (including *thoracica*) and possibly *chrysolaema* represent a single stock of western Greater Antilles ground lizards, of which *dorsalis* has been long isolated on Jamaica. *Ameiva auberi* has been long in residence on Cuba and the Isla de Pinos, and is a recent arrival in the Bahamas. *A. dorsalis* merits specific status, whereas *thoracica* does not.

Savage (1966:742-743) has suggested that *Ameiva* and *Cnemidophorus* represent, respectively, South American and Middle American derivatives of a common ancestral stock. These two genera evolved separately in areas north and south of the Isthmian Link. In the late Cenozoic, with the closing of the Isthmus of Panama, *Ameiva* invaded Central America and *Cnemidophorus* South America, with limited evolution in the newly invaded area in each case. If such a history is essentially correct (and the continental data support it), a relationship between *A. undulata* and *auberi-dorsalis-*(?*chrysolaema*) seems less likely. Final and "permanent" closure of the Isthmian Link took place in the Pliocene, although prior to that time there had been a series of stepping-stone islands scattered between South America and Mexico. It is possible that a South American *Ameiva* stock reached Middle America sometime earlier, during the Cenozoic, and thence reached Cuba (and later, Jamaica, and still later, the Bahamas). In fact, the diversity of Greater Antilles *Ameiva* (contrast for example such species as *A. chrysolaema* and *A. lineolata* on Hispaniola, or even such dissimilar species as *A. maynardi* and *A. auberi*, occurring on islands in or near the same archipelago) makes it seem very unlikely that this high degree of differentiation on the species level has occurred since Pliocene, or later, invasion of the Greater Antilles from the continent.

On the other hand, considering the diversity of Lesser Antilles *Ameiva* (see Baskin and Williams, 1966, for an incisive discussion), it seems more likely that *all* Antillean *Ameiva* are related to one or more South American stocks. It also seems likely that the Antilles as a faunal region has been colonized by leap-frogging and island-hopping, primarily by South American stocks. Such a history, being independent of the Isthmian Link events, would allow sufficient time for *Ameiva* to have reached many of its Antillean outposts. Although absent in the Cayman Islands and some of the northern and southeastern Bahamas, *Ameiva* is one of the most widespread reptilian genera in the Antilles, exceeded in total distribution only by *Anolis* and *Sphaerodactylus*. This history would also allow sufficient time for

the various major "kinds" or "styles" of *Ameiva* to have evolved. And it would not demand that the great specific *and* subspecific diversity of the western Caribbean *Ameiva* be accomplished more or less synchronously since the Pliocene.

Along these lines, it is pertinent that presumably the Great Bank in the Bahamas was inundated throughout the Pliocene and variably or partially submerged during the Pleistocene (Rabb and Hayden, 1957:8). This implies that all the Bahamian subspecies of *A. auberi* have had a very recent origin (at least post-Pliocene, and possibly even more recent) since the Great Bank was generally not available earlier for colonization from Cuba. The same statement is true of some of the Cuban subspecies; *extraria*, *extorris*, *zugi*, and *galbiceps* occupy low cays and islets that were inundated during the Pliocene. These cays and islets could not have been invaded from the Cuban mainland or the Isla de Pinos until after they emerged from the ocean. The total history of *A. auberi* in the Bahamas and Cuba indicates, by the very recency of some of the land masses occupied by quite distinctive subspecies, that there had long been a resident stock of *Ameiva* (presumably remotely derived from South America) on Cuba. There diversification occurred, and at an early date, by overseas transport, *Ameiva* arrived in Jamaica (probably from eastern Cuba). At a much later date, *Ameiva* reached the Bahama Islands' Great Bank. I suggest the derivation of *dorsalis* from *auberi*, rather than the reverse, because *dorsalis* is relatively constant in its pattern features throughout Jamaica, suggesting that it is the derived rather than basic species of the *auberi-dorsalis* pair.

Given a long period of residence of *A. auberi* on Cuba and the ecological, physiographic, and geographic diversity of Cuba as well, the subspeciation of *A. auberi* there is expected. The eastern subspecies (of which it has been noted that *sabulicolor* and *granti* are rather like *A. dorsalis* in dorsal pattern) seem to have retained the original style of dorsal pattern of the basic stock. The expanding and fading median dorsal line, in fact, is a general feature of *A. auberi* from northeastern Camagüey to Cabo Cruz (although *ustulata* on the south-central Oriente coast has diverged from this basic Oriente pattern) in the subspecies *sublesta*, *citra*, *granti*, *sabulicolor*, and *hardyi*. These races presently (with the exception of *sublesta* and *citra*) are associated with coastal regions bounded by interior mountains. It seems possible that all the eastern subspecies from *sublesta* to *hardyi* represent radial derivatives from one (or several) eastern mountainous

areas that served as refuges in Pliocene-Pleistocene time. Subsequent differentiation along the coast has resulted in the development of the large and orange-throated southwestern *hardyi* (whereas the more eastern subpecies *ustulata, sabulicolor,* and *granti* are black-throated) and the geographically intermediate *ustulata,* which lacks the expanding and fading dorsal line. The extreme peripheral members of this group, *citra* and the insular but closely adjacent *sublesta,* are subspecies that are farthest removed from any eastern massif but presumably were derived from such areas (see Fig. 1 for a graphic rendition of these and the following statements).

The central Camagüey subspecies *llanensis* is allied most closely to *galbiceps* from the Cayos de las Doce Leguas. The apparent absence of *Ameiva* from most of Camagüey Province has been previously mentioned (Schwartz, Section I), and it has been admitted that this absence may be more apparent than real. The Doce Leguas cays are low and surely would have been inundated with any appreciable rise in sea level. Thus colonization of these islands must have taken place since their last emergence from the sea. The occurrence on the Doce Leguas cays of two endemic subspecies of lizards, as well as other reptiles (one of which, *Sphaerodactylus argus,* is purely Jamaican in origin) indicates that sufficient time has elapsed since the appearance of these cays above the ocean surface to allow not only the arrival of Cuban reptiles there, with subsequent racial differentiation, but the waif arrival of a Jamaican reptile also. Presumably, despite the present absence of *Ameiva* from the adjacent Camagüeyan coast, *galbiceps* and *llanensis* represent common derivatives of an ancestral Cuban form. The patterned dorsal fields and non-black throats ally these two races.

Turning to the extreme western end of Cuba and the Isla de Pinos, there are two major groups of subspecies involved: (1) the very large and yellow-throated *procer* with a relatively wide distribution, and (2) the smaller races *cacuminis, denticola, paulsoni, secta, marcida,* and *zugi.* Of the second complex, *paulsoni-secta-marcida-zugi* represent a southern Pinar del Río-Isla de Pinos-Archipiélago de los Canarreos group. The floral and faunal relationships of Pinar del Río to the Isla de Pinos have been pointed out repeatedly (Schwartz, 1959a:138; 1959b:61; 1959c:118), and it is not surprising that the subspecies of *Ameiva* in these two regions show similarities. Of the four races, *paulsoni* and *zugi* (usually with non-black throats, and *zugi* with its extreme obsolescent dorsal pattern) are the most divergent. It

must be reealled, however, that *marcida* on the southern Isla de Pinos is apparently in the process of losing the black-throated condition, and that one population of otherwise pale-throated *zugi* (Cayo Cantiles) contains some black-throated individuals. There seems little doubt that *zugi* has been derived along the Archipiélago de los Canarreos from the adjacent and partially black-throated *marcida*. Possibly this group of four subspecies represents radial dispersal from an Isla de Pinos haven, *paulsoni* having arrived in its present south Cuban coastal area by overseas transport or by overland dispersal while the Isla de Pinos and Cuba were connected, and *marcida* having differentiated from *secta* on the southern third of the Isla de Pinos (because of the intervening Ciénaga de Lanier) at a more recent date, with *zugi* a derivative of *marcida* on the Archipiélago. Even slight rises in sea level would bring about division of the Isla de Pinos into two separate islands, and this may have helped reinforce the genetic distinction of *secta* and *marcida* from each other.

The distribution of *procer*, centering as it does in the Sierra de los Organos, would indicate that it has had a long, independent history in this range, which was part of the Cuban archipelago during Pliocene-Pleistocene time. Since restoration of the surrounding lowlands, *procer* has expanded its range into the lower areas surrounding the Sierra de los Organos and has reached as far to the southwest as the base of the Península de Guanahacabibes and as far east as Cabañas.

The two Guanahacabibes subspecies, *denticola* and *cacuminis*, have been discussed in detail previously (Schwartz, Section I). It is difficult to associate *denticola* with its adjacent neighbor *procer*, and *denticola* is better regarded as a western derivative of the *paulsoni* (and thus indirectly of *secta*) stock, with *cacuminis* as either a terminal or northern peninsular coast population with non-black throats.

To the east of the range of *procer*, there is a series of northern coastal subspecies from Habana Province to Las Villas Province (*auberi-pullata-gemmea-garridoi*) of which one (*pullata*) has a black chest and throat patch. In addition to these subspecies, *abducta* occupies the Península de Hicacos, and *extraria* and *extorris* occur on the Archipiélago de Sabana, off the northern Las Villas coast. The same style of throat and chest coloration and pattern as *pullata* occurs in the southern Las Villas *atrothorax*, whereas the latter's closest geographic relative is *peradusta*, a subspecies that carries ventral blackening to an extreme in the species. *A. a. atrothorax* occupies that part of the

southern coast immediately adjacent to the high Sierra de Trinidad, whereas the north coast races occupy in general the coasts adjacent to more interior uplands — the Escaleras de Jaruco, the Sierra Morena, and the Sierra de Jatibonico. A single subspecifically unidentifiable specimen from northeastern Las Villas is from the Sierra de Jatibonico, and the small series from north of the Sierra de Cubitas completes the records of *Ameiva* from this northern coast between Habana and central Camagüey provinces. The occupation of lowlands immediately adjacent to interior uplands on both north and south coasts (of these subspecies, *peradusta*, which I consider an *atrothorax* derivative, is the farthest removed from any immediately adjacent montane mass) of central Cuba suggests that in each case the more or less widespread *Ameiva* had been forced to retreat during extensive Pleistocene inundation to a series of disjunct islands, whence it subsequently expanded with emergence of surrounding lowlands. If such is the case, then *auberi* and *pullata* may have been derived from an Escaleras de Jaruco population, with the peripheral *abducta* evolving on an offshore island which is today the Península de Hicacos, *gemmea* and *garridoi* from the Sierra Morena (or possibly *garridoi* from the Sierra de Jatibonico), and *atrothorax* (and, more removed on the west side of the Bahía de Cienfuegos, *peradusta*) from the Sierra de Trinidad. The differences pointed out between coastal *pullata* and the few specimens from the interior of Matanzas Province at San Miguel de los Baños may indicate that these latter have been derived from still another isolated population on the Bejucal-Madruga-Limonar anticline, in which range San Miguel lies. The similarity in chest and throat pattern between the north coast *pullata* and the south coast *atrothorax* may be interpreted (in this area) as the retention of a primitive throat pattern by two presently disjunct populations which previously may have been continuous across the area now occupied by the La Habana-Matanzas Red Plain (Llanura roja la Habana-Matanzas; see Marerro, 1951:474 *et seq.*), and across which these two races may have restablished contact.

The general association of Cuban *A. auberi* with lowland coastal regions allied to nearby mountains, and the contention that these adjacent mountains were insular refugia during the period when Cuba was an archipelago, support the differentiation of *A. auberi* into a series of races, these races having been at least partially differentiated during the period of inundation of the lowlands. The fact that the center of distribution of one race (*procer*) is still primarily in the

interior uplands lends added support to this theory. The only serious exceptions to the montane refugia are *llanensis* in Camagüey Province, and *cacuminis* and *denticola* on the Península de Guanahacabibes. The latter two races, as has been pointed out, may be more recent western derivatives of *paulsoni* (and its Isla de Pinos relatives), whereas *llanensis* occupies an interior region adjacent to the Sierra de Cubitas. If the unnamed population north of the Sierra de Cubitas is presumed to represent the original residual Cubitas population, then *llanensis* can hardly also be so considered. In southern Camagüey Province is the Sierra de Najasa. This range is geographically intermediate between the distribution of *llanensis* and the Doce Leguas subspecies *galbiceps*, and possibly *llanensis* represents the Najasa isolate that has subsequently invaded the north as far as the Sierra de Cubitas and also reached the Laberinto de las Doce Leguas.

As I mentioned above, it is obvious that some insular subspecies of *A. auberi* (*extraria*, *extorris*, *zugi*, *galbiceps*, and possibly *sublesta*) have had more recent development and differentiation from their mainland relatives. These races are in most cases closely related to the subspecies on the adjacent mainland: i.e., *sublesta* to *citra*, *zugi* to *marcida*, and *galbiceps* to *llanensis*. The differences between *extraria* and *gemmea*, however, are much greater than those between the above racial pairs. Considering the long and linear extent of the north coast *cayería* from Punta Hicacos in the west to Cayo Sabinal in the east, and considering that Cayo Sabinal is inhabited by the westermost member of the Oriente complex of races, it is possible that *extraria* (and *extorris*, which is a local derivative of *extraria*) has been derived by serial colonization and invasion of the northern cayería from the east, rather than from the coast directly to the south. The resemblances between *extraria* and the eastern subspecies are such that *extraria* may well be more closely related to *sublesta* and *citra* than the more geographically close *gemmea* and *garridoi*.

If the above interpretation of the history of *Ameiva* in Cuba is correct, then the suggestion that the distribution of *A. auberi*, composed of widely disjunct populations separated by at times broad areas where no ground lizards are known, is a relictual one is reinforced. Those areas from which no *Ameiva* are known are thus interpreted as regions that *A. auberi* has not yet penetrated. These regions generally are also farthest removed from montane refugia. Although *A. auberi* is absent today from some regions like the highlands of the Sierra Maestra and extreme eastern Oriente because of ecology and elevation,

the absence of the species from other apparently suitable areas may be explained by this suggested history of the species in Cuba and the Isla de Pinos.

Considering the Bahamian subspecies as a whole (see McCoy, section II, for details), the consistency of presence of black throat and chest pigment (reduced but still present in *focalis*) suggests that the parent Cuban population of the Bahamian stock was black-throated, and logically would be from the northern Cuban coast. The closest present point of the Bahama Islands and Cuba is along the southwestern arm of the Great Bahama Bank paralleling the Camagüey *cayería* between Cayo Coco and Cayo Guajaba. Here the Great Bank is separated from Cuba by the narrow (50 kilometers) but deep (locally to over 1000 fathoms) Old Bahama Channel. At this closest point of the Cuban insular platform and the Great Bahama Bank, there are but two tiny and remote Bahamian islets (Guinchos Cay and Cay Lobos) that are not known to harbor *Ameiva*. To the east, along the southeastern margin of the Great Bank and about 110 kilometers north of Cabo Lucrecia in Oriente, lie the southernmost Bahamian islands with any considerable land mass, the Ragged Island group. *Ameiva a. bilateralis*, one of the most distinctive of the Bahamian subspecies, occupies these islands.

It might be expected that *bilateralis* would be like one of the north Cuban coastal subspecies. *Ameiva auberi granti*, by virtue of its occurrence from Banes eastward to Baracoa, would be a logical Cuban possibility. *A. a. granti* is also black-throated, which would satisfy one of the pigmentary requirements of a Cuban ancestor for the Bahamian lizards. Along the northern Cuban coast, other black-throated subspecies are *pullata* and *extorris*. The former lies far to the west in Matanzas Province and the latter has a limited distribution on one of the cays of the Archipiélago de Sabana. The two other eastern Cuban north-coast races, *sublesta* and *citra*, have colored throats.

Despite the proximity of *granti* and *bilateralis*, these two subspecies have little in common other than throat and chest color. *A. a. bilateralis* is a pale but distinctly lined subspecies with broad, sharp-edged and white lateral stripes bordering black lateral fields. The dorsal stripe is present but faded, maintains its intensity and width for the length of the dorsum, and does not become progressively fainter and wider as is proceeds posteriorly. *A. a. granti* on the other hand is a rich reddish brown above, has a yellow and contrasting median dorsal

line which expands and becomes paler posteriorly, narrow and often fragmented dorsolateral lines, and lateral fields with scallops or internal spotting. *A. a. bilateralis* is generally faded in aspect with boldly contrasting solid black lateral fields, whereas *A. a. granti* is a richly colored and brightly patterned lizard. Two subspecies could hardly be more different in pattern and color than these two. As far as meristic data are concerned, *bilateralis* and *granti* have identical means (75.9) of fourth-toe scales and comparable means of femoral pores (24.1 and 25.7), but *bilateralis* has a higher mean number (28.7) of fifteenth verticil scales than does *granti* (25.1). All things considered, Cuban *granti* and Bahamian *bilateralis* seem not to be closely related.

Of the north Cuban coast subspecies, *bilateralis* most closely resembles *extraria* and *extorris*. Of this pair, *extorris* is black-throated but is known to occur on only one islet. All three subspecies are faded in appearance, but *extorris* has an unpatterned dorsum and *extraria* has a yellow median dorsal line that fades posteriorly. Finally, both *extraria* and *extorris* lack lateral fields, quite in contrast to the prominence of these features in *bilateralis*. Of the three subspecies, the means of fourth-toe scales in *extraria* (76.3) and *bilateralis* (75.9) are comparable, whereas that of *extorris* is much lower (69.5). The series of *extorris* is small, however. Femoral pore means (24.1 in *bilateralis*, 23.8 in *extraria*, 25.3 in *extorris*) are variable, with *bilateralis* intermediate between the two Cuban subspecies, and means of fifteenth verticil scales (28.7 in *bilateralis*, 26.5 in *extraria*, 25.4 in *extorris*) show that *bilateralis* exceeds both Cuban subspecies in this count. It is interesting to note that, of the Bahamian subspecies, *bilateralis* ranks next to last in fifteenth verticil means (range of Bahamian means 28.3 to 31.6). Means of fifteenth verticil counts in all Cuban subspecies vary from 24.9 to 29.5. Thus, in general Cuban subspecies as a group have fewer scales in the fifteenth caudal verticil than do Bahamian subspecies as a group. The low fifteenth-verticil mean of *bilateralis* suggests that, of all the Bahamian races, it may indeed be most closely related to the Cuban stock.

Everything considered, the differences between the pertinent north Cuban coastal subspecies of *A. auberi* and the most southern of the Bahamian subspecies, *bilateralis,* suggest that the *Ameiva* invasion of the Great Bank may well have been along that section of Cuba that most closely approximates the Great Bank today, i.e., the northern *cayería* between Punta Hicacos in Matanzas and the Bahía de Nuevitas. At least there are some similarities between some of the subspecies

along this coast and *bilateralis*. Although the Ragged Islands are closest geographically to the Oriente coast, there is little similarity between *bilateralis* and *granti*.

This postulated relationship is of course questionable. Resemblances between *extraria* and *bilateralis* may be due to responses to small-islet environments and more arid conditions. It should be recalled that *granti* occupies one of the wettest and most densely forested portions of Cuba, whereas *extraria* inhabits a series of cays that are open, more or less arid, and lack dense forests. It is pertinent that *zugi*, a subspecies of the exposed and dry islands in the Archipiélago de los Canarreos, is also pale. Remarkably, of all the Cuban subspecies, *bilateralis* most closely resembles the far-removed *zugi*. Of the pale and faded Cuban subspecies, only *zugi* regularly retains the black lateral fields. This surely is an instance of convergence.

McCoy (section II) has commented succinctly on the evolution and radiation of *A. auberi* within the Bahama Islands themselves. In the Bahamas, *Ameiva* occupies solely the Great Bahama Bank and has not succeeded in invading the Little Bahama Bank or in crossing the Crooked Island Passage. It has reached Cat Island, which is peripheral to the Great Bank proper. The remarkable vagility of *A. auberi* is demonstrated by its ability to reach some remote islets on the bank. Green Cay and the Bimini Islands are two striking cases in point. Of the Bahamian subspecies, *kingi*, *richmondi*, and *multilineata* seem to form a rather compact group of predominantly lineate subspecies that occupy islands to the west of the Tongue of the Ocean dividing the Great Bank into two nearly equal portions. To the east of the Tongue of the Ocean, *thoracica*, *felis*, and *focalis* form a less integrated group, with *felis* most divergent in dorsal and lateral pattern. *A. a. obsoleta* might also be included with this assemblage. *A. a. bilateralis* stands alone in its strikingly contrasting dorsal pattern, although it too is probably related to the eastern Great Bank subspecies, most closely to the adjacent *obsoleta*. There seems little reason to reject a hypothesis that the Bahamian subspecies represent two basic stocks (but not likely two different invasions) that were early separated by the Tongue of the Ocean. After this early division, distinctive subspecies on each island or island group evolved.

A. a. felis requires special comment. This subspecies occupies the only island (Cat) peripheral to the Great Bank (although there must have been a former connection, in contrast to several remote Bahamian Islands that have never been connected) inhabited by *A. auberi*. Mc-

Coy (section II) stated that *felis* stands alone among the Bahamian races in that it possesses spotted lateral fields. Patterned lateral fields are of regular occurrence in many Cuban subspecies, however. The occurrence of this character in *felis*, so far removed geographically from Cuba and separated from it by the two intervening subspecies *obsoleta* and *bilateralis* is especially intriguing. Considering the isolated position of Cat Island in reference to the Great Bank and its membership in the eastern seaward volcanic arc, the resemblance of *felis* to some Cuban subspecies in this character may be of added significance. It seems possible that the Cat Island *A. auberi* have had a somewhat different history from the balance of the Bahamian subspecies. Detailed studies of two other Bahamian reptiles (*Sphaerodactylus decoratus*, Thomas and Schwartz, 1966:7; Thomas, 1968; *Anolis distichus*, Schwartz, 1968b) have shown that the Cat Island populations are peculiar and neither readily assignable to adjacent subspecies nor sufficiently and constantly divergent to be regarded as nomenclaturally distinct. In both cases the Cat Island populations show peculiar admixtures of characteristics of populations from adjacent islands. The contrast between the situation in *S. decoratus* and *A. distichus* on one hand, and *A. auberi* on the other, is quite striking in this regard, since *felis* is an exceptionally distinct subspecies. Apparently the reptile fauna of Cat Island has had a varied history, and presumably this is due to the location of Cat, peripheral to the Great Bank mass itself, and possibly to a geological persistence it may have enjoyed.

In summary, I interpret the history of *Ameiva auberi* as follows. A pre-*auberi* stock arrived on Cuba from South America, by island-hopping and overseas transport, at some early date. Evolution of this stock into subspecies began on Cuba, and differentiation was aided by the successive partial inundations that occurred during Cuba's geological history, resulting in archipelagos variously formed and later variously recombined. Sometime in its history, *Ameiva* reached Jamaica, probably from the southern Oriente coast, and in Jamaica arose *A. dorsalis*. During the Pliocene-Pliestocene, Cuba was once more a series of islands, which the present montane masses roughly outline. On these islands, *Ameiva* continued its local evolution, and with the recession of the seas and final emergence of the Cuban lowlands, the lizards were able once more to recolonize not only the resultant lowlands but also to reach the Great Bahama Bank from the northern Cuban coast in the region between Las Villas and Camagüey. With establishment of *Ameiva* in the Cuban lowlands from montane refugia,

various subspecies have evolved because of isolation and intensification of differences that had their inceptions while the lizards occupied their Pleistocene refugia. On the Bahama Islands, two (or perhaps three) basic stocks have resulted in two major divisions of the subspecies of those islands, one east of, the other west of, the Tongue of the Ocean. I interpret all extant subspecies of *A. auberi* as being quite recent in development. Such an interpretation is mandatory since much of the land area now occupied by *A. auberi* has been permanently available only since the Pleistocene.

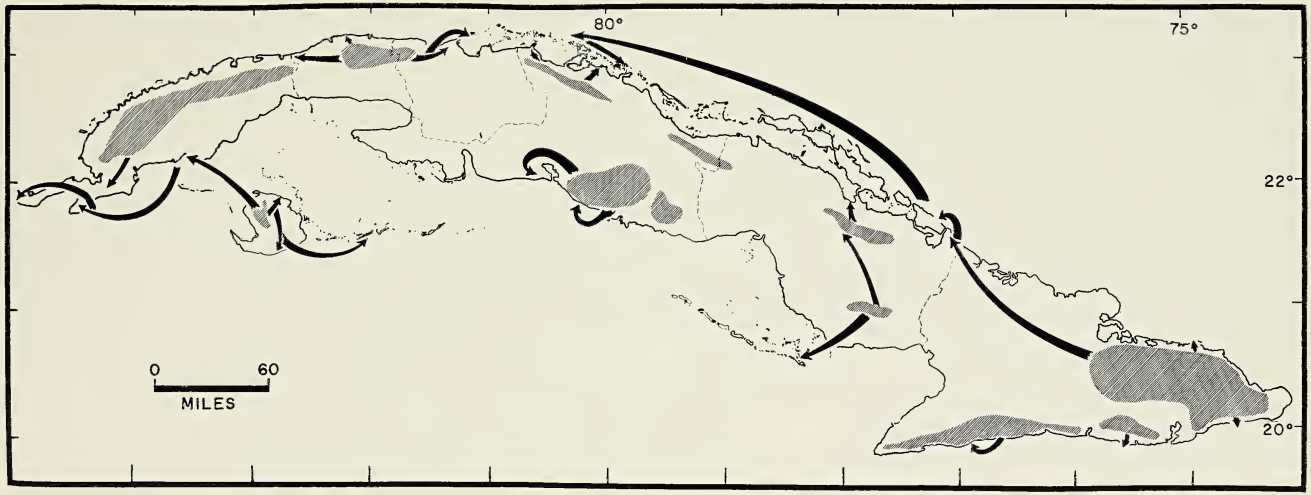


Fig. 1. Map of Cuba and the Isla de Pinos. Shaded regions represent upland areas. These areas were Pleistocene refugia for *Ameiva* and from them the lizards subsequently invaded the lowlands. Arrows suggest paths from refugia where the various subspecies (see Fig. 1, Schwartz, Section I) originated. The extremely elongate arrow along the northern Las Villas-Camagüey coast does not imply direct colonization of the Archipiélago de Sabana from Cayo Sabinal. Presumably this colonization was effected serially via the coastal *cayería*.

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Volume 41 Annals of Carnegie Museum Article 5

REPORTS ON THE MARGARET M. CARY—CARNEGIE MUSEUM EXPEDITION TO BAJA CALIFORNIA, MEXICO, 1961.

7. The Family Hesperiidae (Lepidoptera)

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This is the seventh of a series of papers based on the Margaret M. Cary — Carnegie Museum Expedition to Baja California, Mexico, 1961, to appear in the Annals of Carnegie Museum. For an account of the itinerary and description of localities, see the first paper in this series [Richard M. Fox, Ann. Carnegie Mus., 36 (16): 181-192]. Except as noted, all specimens including type series discussed in the following study are in the collection of Carnegie Museum.

Introduction

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The Hesperiidae of Baja California have been reviewed by MacNeill (1962). This paper adds locality records and confirms the occurrence in the Cape region of some poorly known skippers. Two additional species are added to the list of peninsular skippers, the rare *Thorybes valeriana* (Plötz) and *Pyrgus o. oileus* (Linné). Two new peninsular subspecies were described in a preceding paper (Miller and MacNeill, 1969). The list of hesperiids is by no means complete; there is still an undescribed subspecies of *Paratrytone melane* (Edwards) in the high mountains south of La Paz; *Prenes californica* A. G. Weeks is still an unknown butterfly; possibly there are other species of *Erynnis* in the mountains. And the spring skipper fauna has been poorly sampled.

The Expedition personnel collected 1558 hesperiids of 87 species. Of these, 411 specimens of 81 species were taken on the mainland, and 1147 specimens of 26 species collected on the peninsula. Four of these species are represented by separate mainland and peninsular subspecies.

In addition to the Expedition material, I have examined a small number of skippers from the San Diego Natural History Museum, and these are reported under the appropriate species below.

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I wish to express my appreciation to the late Dr. Richard M. Fox and to Harry K. Clench of the Section of Insects and Spiders, Carnegie Museum, for their encouragement and suggestions. Dr. C. Don MacNeill identified some specimens for which we had no comparative material, and generally was most helpful. Thanks go to Dr. C. F. Harbison, San Diego Natural History Museum, for the loan of specimens. Finally, the greatest thanks are due Mrs. Margaret M. Cary of Philadelphia, Pennsylvania, for making this study possible by sponsoring the Expedition.

Zoogeography, Cape Region Hesperiidae

The occurrence outside the Cape region of the Hesperiidae thus far recorded from there is summarized in Table 1. From these data it becomes apparent that not all the skippers in the region were derived from the same geographic source, nor were they simultaneous arrivals at the tip of the peninsula. The 28 species show five general distributional patterns, which are summarized below.

1. *Basically temperate species showing affinities to the California mountains.* There are two of these species known from the tip of the peninsula at present, both in the high mountains of the Sierra de la Laguna. When these mountains become better collected, particularly in the spring, the number will probably increase. Both species are represented in the Cape region by endemic subspecies, *Erynnis tristis pattersoni* Burns, and an unnamed subspecies of *Paratrytone melane* (see MacNeill, 1962: 110-111). These two primarily temperate skippers have also managed to penetrate the Mexican highlands, with *melane* extending as far south as the Cerro de la Muerte in Costa Rica. The differentation shown by these butterflies in the Cape region indicates long isolation from their northern relatives, and their temperate habitat on the peninsula suggests that they arrived at a time when the peninsula was moister and perhaps cooler than at present. Truxal (1960: 168) discusses the post-Miocene extension of the Arcto- and Madro-Tertiary geofloras into the peninsula, and it seems likely that the introduction of *tristis* and *melane* into the Cape region was synchronous with this event.

2. *Sonoran desert species neither found in southern California nor significantly penetrating the tropics.* There are five of these species: *Thorybes valeriana* (Plötz), *Systasea zampa* (Edwards), *Pyrgus philetas* Edwards, *Nastra neamathla* (Skinner and Williams) and *Lerodea dysaules* Godman. The lack of differentiation of the Cape region populations of these species indicates some interconnection with

TABLE 1

DISTRIBUTION OF HESPERIIDAE SPECIES OF THE CAPE REGION SHOWING ENDEMICITY OF CAPE FAUNA

Species	Distribution Outside Cape Region							
	BCN	SC	CM	AM	ASD	MH	SM	SA
Chioides catillus				a	a	a	a	b
Urbanus proteus	a?	a	a	a	a	a	a	a
dorantes	?			b	b	b	b	b
Thorybes valeriana					a	a?		
Cogia hippalus	b?		b	b	b	b	b	b
Staphylus ceos	a	a			a			
Systasea zampa	a				a			
Chiomara asychis					b	b	b	b
Erynnis funeralis	a	a	a	a	a	a	a	a
tristis	b	b	b	b		b		
Pyrgus communis	a	a	a	a	a	a	b	b
oileus					a	a	a	a-b
philetas	a				a			
Heliopetes domicella	a?				a	a	a	b
laviana	a?				a	a	a	b
Pholisora catullus	a	a	a	a	a	a		
Nastra neamathla	a?				a			
Copaeodes aurantiaca	a	a			a	a		
Hylephila phyleus	a	a	a	a	a	a	a	a-b
Polites sabuleti	b	b	b	b	b			
Atalopedes campestris	a	a	a	a	a	a	a	a
Paratrytone melane	b	b						
Amblyscirtes tolteca					?	?	?	
Lerodea eufala	a	a	a	a	?	?	?	a-b
dysaules	a?				a	a		
Calpodes ethlius	a?	a	a	a	a	a	a	a
Panoquina panoquinoides	a	a			a		b	b

a = subspecies same as, b= subspecies different from, those found in the Cape region. Abbreviations for places outside the Cape region are: BCN, Baja California Norte; SC, southern California; CM, California mountains; AM, Arizona mountains; ASD, Arizona-Sonora desert; MH, Mexican highlands; SM, southern Mexico; SA, South America.

mainland populations, or isolation of relatively short duration. In either event, these skippers are probably later, perhaps even post-Pleistocene, arrivals. All are lowland butterflies.

3. *Sonoran desert species that have penetrated California but not the tropics.* There are four of these species: *Staphylus ceos* (Edwards), *Pholisora catullus* (Fabricius), *Copaeodes aurantiaca* (Hewitson), and *Polites sabuleti* (Edwards). One of these is represented by an endemic Cape region subspecies, *Polites sabuleti margaretae* Miller and MacNeill, but the peninsular populations of the other three species are indistinguishable from their mainland counterparts. *P. sabuleti* inhabits the coastal grasslands on the peninsula, while the others are of more general occurrence in the lowlands. All are probably fairly recent arrivals on the peninsula. *P. sabuleti* is a well-known polytypic species,

whereas the others have no presently recognized geographic isolates.

4. *Sonoran desert, and humid or subhumid, tropical species not found in southern California.* There are eight species in this group: *Chioides catillus* (Cramer), *Cogia hippalus* (Edwards), *Chiomara asychis* (Stoll), *Pyrgus oileus* (Linné), *Heliopetes domicella* (Erichson), *H. laviana* (Hewitson) and *Amblyscirtes tolteca* Scudder. This group is second only to Group 1 in degree of endemism. Three of the species have endemic Cape region subspecies, *Urbanus dorantes calafia* (Williams), *Cogia hippalus peninsularis* Miller and MacNeill, and *Chiomara asychis pelagica* (Weeks), and the peninsular populations of *catillus* and *laviana* may be distinguished from their mainland relatives by differences too slight to warrant naming them. Fives species, *catillus, laviana, domicella, asychis* and *oileus,* are also represented in South America by different subspecies, while *tolteca* has two subspecies in Mexico: the nominate one in southern Mexico and *prenda* Evans in Sonora. Most, if not all, these species are earlier arrivals in the Cape region, probably post-Miocene and certainly pre-Pleistocene.

5. *Widely distributed tropical and subtropical species.* There are eight species in this category: *Urbanus proteus* (Linné), *Erynnis funeralis* (Scudder and Burgess), *Pyrgus communis* (Grote), *Hylephila phyleus* (Drury), *Atalopedes campestris* (Boisduval), *Lerodea eufala* (Edwards) *Calpodes ethlius* (Stoll), and *Panoquina panoquinoides* (Skinner). None of these has an endemic Cape region subspecies, and in only one species (*panoquinoides*) can the peninsular material be distinguished from either Mexican or Californian specimens. *P. panoquinoides* is unique in the group as a colonial butterfly intimately associated with coastal or even salt-marsh grasses. Five of the other members of the group, *proteus, phyleus, campestris, eufala,* and *ethlius,* are strong-flying tropical skippers that have been taken as far north as the northern United States, but they probably are not resident there. These species arrived in the Cape region, probably in recent times, either over water or via land, through the Sonoran desert. *C. ethlius,* though, is so intimately associated with cannas wherever it is found that it is impossible to ascertain whether it actually arrived in the Cape region under its own power or was imported by man with his ornamental cannas. No specimens were taken on the peninsula except in canna gardens. The other two species, *E. funeralis* and *P. communis,* are widespread butterflies which certainly arrived recently, probably by way of the Sonoran desert.

In summary: all members of Group 1 are represented by endemic subspecies derived from the California mountains, and they probably date from the post-Miocene floral invasion of the peninsula; all members of Group 2 are recent arrivals from the Sonoran desert; the members of Group 3 arrived fairly recently from the Sonoran desert, although *sabuleti* may be an earlier immigrant; the members of Group 4 are early arrivals from the Sonoran desert, as evidenced by their distinctness from mainland populations; and the Group 5 skippers are recent arrivals of widely distributed, strong flying species, one of which, *ethlius*, may have been introduced by man.

SYSTEMATIC ACCOUNT

In the following account, no attempt has been made to separate the peninsular from the mainland skippers, except by separately listing the records from the various Mexican states. I have listed the material that was available from the San Diego Museum of Natural History separately at the end of the discussion.

Subfamily PYRRHOPYGINAE

Mysoria affinis (Herrich-Schäffer), 1869.

This skipper is known from the western lowlands of Mexico and occurs infrequently in Guatemala (Evans, 1951: 69). It was not taken on the peninsula; indeed, no pyrrhopygine is known from there.

SINALOA: 16 mi. north of Mazatlán, 1 ♀ 29-x.

Subfamily PYRGINAE

Phocides pigmalion belus Godman and Salvin, 1893.

Evans's description (1952: 13) of this Mexican subspecies mentions "... costal spot over cell spot vestigial." While this description applies to males, the females have the costal spot well developed. This skipper is not common in collections.

SINALOA: Mazatlán, 2 ♂ 1 ♀ 24-x, 1 ♀ 26-x.

Proteides mercurius mercurius (Fabricius), 1787.

The single specimen taken by the mainland party is in all respects referable to the mainland subspecies of this skipper. The species is general throughout the Neotropics.

SINALOA: Urías, 2 mi. south of Mazatlán, 1 ♀ 31-x.

Epargyreus exadeus complex.

Although this species was recorded from Baja California, MacNeill (1962: 95) has discussed the problems inherent in such a record. The three specimens collected by the mainland party show another of the

problems—exact species determination in the *exadeus* complex is difficult, if not altogether impossible at present. When I was at the British Museum in 1964 I examined the series of *Epargyreus* arranged by Evans and found that it was confused. The entire genus, and particularly the *exadeus* complex, is impossible to identify with certainty using Evans's keys (1952). A careful and exhaustive revision of this genus is necessary before any certain identifications may be made.

The males before me apparently represent two species: the one from 19 miles east of Concordia, Sinaloa, keys to *socus* Hübner, but the genitalia are like *exadeus* Cramer. The one from 2 miles east of Concordia keys to *spina* Evans. The female appears to be of *spina.*

SINALOA: 2 mi. east of Concordia,, 1 ♂ 25-x; 17 mi. east of Concordia, 1 ♀ 1-xi; 19 mi. east of Concordia, 1 ♂ 25-x.

Polygonus leo leo (Gmelin), 1790.

This species, which occurs generally throughout the Neotropics, was represented by a single specimen taken by the mainland party. This specimen is similar to a long series from Yucatán and definitely is referable to the nominate subspecies.

SINALOA: 17 mi. east of Concordia, 1 ♂ 1-xi.

Chioides catillus albofasciata (Hewitson), 1867.

This species in its several subspecies is found throughout much of tropical America. The subspecies *albofasciata* is recorded from Arizona through Central America and into Colombia (Evans, 1952: 56). This species is not an inhabitant of the very wet tropical forests. It prefers drier, more open situations than do other "long-tails."

C. c. albofasciata is an avid flower visitor, showing definite preferences for zinnias in cultivated gardens, the "desert willow" (*Chilopsis linearis*), and the flowers of large Compositae in the arroyos. These butterflies are very pugnacious and will engage others in mock combat at any time.

This species was taken both on the peninsula and in Sinaloa, but it is surprisingly absent from collections made in Sonora. I have never seen *catillus* as abundant as it was in Baja California Sur. The series from the peninsula differs from the mainland representatives in the characteristics described by MacNeil (1962: 95), but the differences are not of a magnitude to warrant description of the Baja California population as an entity distinct from the mainland *albofasciata.*

BAJA CALIFORNIA SUR: La Paz, Hotel Guaycura grounds, 1 ♂ 21-x; Rancho Rosarito, 1 ♂ 23-x; Rancho Vinorama, 2 ♂ 23-x; Rancho El Novillo, 1 ♂ 28-x;

Rancho Palmarito, 1 ♂ 1 ♀ 27-x, 1 ♀ 31-x, 1 ♂ 4-xi, 1 ♂ 30-xi; Arroyo Hondo, near El Triunfo, 1 ♂ 24-x; Mesa Puerta Azul, 1 ♂ 1-xi; Arroyo San Bartolo, 4 ♂ 2-xi, 4 ♂ 3-xi, 1 ♂ [14?]-xi; Boca de la Sierra, 1 ♂ 24-xi; San José del Cabo, 1 ♂ 22-xi, 3 ♂ 2 ♀ 23-xi, 2 ♂ 7 ♀ 25-xi; Arroyo Candelaria, 2 ♂ 1 ♀ 24-xi, 1 ♂.

SINALOA: 48 mi. northwest of Culiacán, 1 ♂ 1 ♀ 23-x; Urías, 2 mi. south of Mazatlán, 1 ♂ 31-x.

Two additional specimens have been seen from the collection of the San Diego Natural History Museum.

BAJA CALIFORNIA SUR: La Paz, 1 ♀ 13-ix-1959; Colonia Calles, 1 ♂ 15-ix-1959 (both C. F. Harbison).

Chioides zilpa zilpa (Butler), 1874.

I can see no difference between the specimens the mainland party took in Sonora and Sinaloa and others from Central America. The specimens are not referable to the northern subspecies *namba* Evans. *C. z. zilpa* is found from Mexico to northern South America.

SONORA: 12 mi. south of Hermosillo, 1 ♂ 1 ♀ 20-x.

SINALOA: 16 mi. north of Mazatlán, 1 ♀ 28-x; Urías, 2 mi. south of Mazatlán, 1 ♀ 31-x; 8 mi. west of Concordia, 1 ♀ 2-xi; 19 mi. east of Concordia, 1 ♀ 25-x, 1 ♂ 1-xi.

Aguna asander asander (Hewitson), 1867.

The nominate subspecies is found generally throughout the Neotropics; there are two West Indian subspecies. This skipper is not found on the peninsula.

SINALOA: 17 mi. east of Concordia, 3 ♂ 2 ♀ 1-xi.

Aguna metophis (Latreille),1824.

This rare species is recorded from Mexico, Nicaragua, Panama, Venezuela, and Brazil (Evans, 1952: 63). A single specimen was taken by the mainland party.

SINALOA: Urías, 2 mi. south of Mazatlán, 1 ♂ 31-x.

Typhedanus undulatus (Hewitson), 1867.

This species is found generally throughout the hotter parts of the Neotropics; it has not been taken on the peninsula.

SINALOA: 48 mi. northwest of Culiacán, 1 ♂ 23-x; Mazatlán, 1 ♂ 24-x; Urías, 2 mi. south of Mazatlán 1 ♂ 31-x; 19 mi. east of Concordia, 1 ♂ 25-x, 1 ♂ 1-xi.

Polythrix octomaculata octomaculata (Sepp), 1848.

The nominate subspecies is found generally throughout the continental Neotropics. It has not been recorded from Baja California.

SINALOA: 16 mi. north of Mazatlán, 1 ♂ 29-x.

Cadatractus arizonensis (Skinner), 1905.

The species is known from Arizona, Mexico and Central America. Rindge (1948: 306) records a specimen of "*Heteropia cyda*" from Baja California which MacNeill (1962: 96) feels may be referable to the present species. No *Codatractus* were taken on the peninsula by the expedition.

SINALOA: 16 mi. north of Mazatlán, 2 ♀ 28-x.

Urbanus proteus proteus (Linné), 1758.

The nominate subspecies is known from the entire continental Neotropics, and is common as far north as the southeastern United States. *U. proteus* is a common species in the better-watered parts of the peninsula.

These butterflies are avid flower visitors and show some pugnacity toward others of their own kind, but not to the same degree as does *C. catillus albofasciata*.

BAJA CALIFORNIA SUR: La Paz, Hotel Guaycura grounds, 2 ♂ 1 ♀ 21-x, 1 ♂ 2 ♀ 22-x, 1 ♂ 4-xi, 1 ♂ 8-xi; Rancho Rosarito, 1 ♀ 23-x; Rancho Vinorama, 1 ♂ 23-x; Rancho Palmarito, 1 ♂ 30-xi, 2 ♂ 4-xii; Arroyo Hondo, near El Triunfo, 1 ♀ 1-xi; Mesa Puerta Azul, 1 ♂ 12-xi; Arroyo San Bartolo, 1 ♂ 1 ♀ 3-xi; Bahía de Palmas, 1 ♂ 3 ♀ 20-xi; San José del Cabo, 1 ♀ 23-xi, 1 ♂ 2 ♀ 25-xi; Puerto Chileno, 3 ♂ 2 ♀ 22-xi, 2 ♂ 26-xi; Arroyo Candelaria, 2 ♀ 24-xi; 4 mi. south of Arroyo Candelaria, 1 ♂ 1 ♀ 24-xi.

Urbanus dorantes dorantes (Stoll), 1790.

In its nominate subspecies this species is one of the commonest hesperiids throughout the American tropics, but the long series from the Cape region of Baja California shows the peninsular material to represent a distinct subspecies. There are also Antillean subspecies.

SONORA: Hermosillo, 3 ♂ 2 ♀ 20-x.

SINALOA: 16 mi. north of Mazatlán, 1 ♂ 28-x, 4 ♂ 29-x; Mazatlán, 3 ♂ 24-x, 2 ♂ 1 ♀ 26-x, 1 ♂ 31-x; Urías, 2 mi. south of Mazatlán, 3 ♂ 1 ♀ 31-x; 5 mi. west of Concordia, 1 ♀ 2-xi; 2 mi. east of Concordia, 1 ♂ 3 ♀ 25-x; 17 mi. east of Concordia, 2 ♂ 3 ♀ 1-xi; 19 mi. east of Concordia, 1 ♂ 1 ♀ 25-x.

Urbanus dorantes calafia (Williams) 1926.

This subspecies was synonymized to nominate *dorantes* by Evans

(1952:92), but he saw no peninsular specimens. The Baja California material is extremely distinct from mainland examples, particularly in the extensive olive-gray overscaling of the upper surface and the grayer under surface lacking the purplish sheen of nominate *dorantes*. A more detailed description of *calafia* is given by MacNeill (1962:97).

These butterflies are avid flower visitors and are found almost anywhere in the Cape region where there is green vegetation. During the morning and late afternoon these butterflies are seen in the open, but during the heat of the day they are active only in shady spots. On two occasions (Mesa Puerta Azul, 1-xi, and Boca de la Sierra, 24-xi) we encountered swarms of *calafia* during the hottest part of the day under trees, feeding at flowers and flying about. No specimens were seen in open sunlight except when they were flying from the shade of one tree to the shade of another. I observed a similar phenomenon with the mainland subspecies in Costa Rica during July and August, 1963. Inasmuch as high temperature, greater amount of incident light, and lower relative humidity all were conditions during the times that we observed these habits, it is impossible to determine which factor governs the *dorantes* habit of seeking shade in midday. Perhaps all factors were in operation. None of the other skippers showed this disposition to escape the sun of the hot part of the day while remaining active. This was the skipper most often attracted to light on the peninsula, and it seems to be somewhat crepuscular, flying much later than most other skippers.

BAJA CALIFORNIA SUR: La Paz, Hotel Guaycura grounds, 1♂ 1♀ 20-x, 2♂ 4♀ 22-x, 2♂ 6-xi, 1♂ 7-xi, 1♂ 8-xi; southeast shore of La Paz harbor, 2♂ 2♀ 10-xi; Rancho Vinorama, 1♂ 23-x; Racho El Novillo, 5♂ 4♀ 28-x; Rancho Palmarito, 3♂ 1♀ 27-x, 1♂ 30-x, 3♀ 31-x, 1♂ 1♀ 4-x, 2♀ 5-xi, 3♂ 2♀ 30-xi, 1♀ 4-xii; Arroyo Hondo, near El Triunfo, 12♂ 8♀ 24-x; Mesa Puerta Azul, 2♂ 24-x, 12♂ 6♀ 1-xi, 9♂ 1♀ 12-xi; Arroyo San Bartolo, 4♂ 1♀ 2-xi, 4♂ 3♀ 3-xi, 1♂ 1♀ 12-xi; Bahía de Palmas, 1♂ 12-xi, 1♂ 16-xi, 3♂ 1♀ 20-xi; roadway 5 kilometers south of Rancho Buenavista, 10♂ 4♀ 25-x; Miraflores, 3♀ 25-x; Boca de la Sierra, 4♂ 8♀ 13-xi, 2♂ 2♀ 24-xi; Arroyo San Bernardo, 1♂ 1♀ 18-xi; Rancho San Bernardo, 500-600 m., 1♂ 17-xi; Arroyo El Rincón, 1♀ 26-xi; San José del Cabo, 2♂ 1♀ 22-xi; 4 mi. SW of San José del Cabo, 2♀ 24-xi; Puerto Chileno, 3♂ 3♀ 22-xi, 1♂ 26-xi; Cabo San Luca, 1♀ 23-xi; Arroyo Candelaria, 2♂ 24-xi; 4 mi. south of Arroyo Candelaria, 2♂ 4♀ 24-xi.

Ten additional specimens have been examined from the collection of the San Diego Museum of National History.

BAJA CALIFORNIA SUR: San Bartolo, 9♂ 24-xi-1956; Todos Santos, 1♀ 10-ix-1958 (C. F. Harbison).

Urbanus teleus Hubner, 1821.

This skipper is found throughout the continental Neotropics but has not been recorded from the peninsula.

SONORA: 16 mi. south of Guaymas, 1 ♂ 21-x.

SINALOA: 16 mi. north of Mazatlán, 1 ♂ 29-x; Urías, 2 mi. south of Mazatlán, 2 ♂ 31-x; 19 mi. east of Concordia, 1 ♀ 1-xi; 17 mi. east of Concordia, 1 ♂ 1-xi.

Urbanus simplicius (Stoll), 1790.

This species has often been confused with the following one, but Tilden (1965) has given the characters for separating them. My own experience in Costa Rica indicated that *simplicius* is more characteristic of wetter environments than is *procne*. The present species is known from Mexico to Paraguay and Argentina.

SINALOA: Mazatlán, 1 ♂ 24-x; 19 mi. east of Concordia, 1 ♀ 25-x.

Urbanus procne (Plötz), 1881.

This is the species generally referred to in the literature as *simplicius* from the United States (see Tilden, 1965). *U. procne* has the wider range of the two, being commonly found from southern Texas to Argentina, and it is more tolerant of dry conditions than is *simplicius*. The present species has not been recorded from Baja California.

SONORA: 12 mi. south of Hermosillo, 1 ♂ 20-x; 16 mi. south of Guaymas, 1 ♂ 21-x; 16 mi. south of Navojoa, 1 ♂ 22-x.

SINALOA: 46 mi. north of Los Mochis, 2 ♂ 22-x; 10 mi. southeast of Los Mochis, 5 ♂ 23-x; 11 mi. north of Mazatlán, 1 ♂ 28-x; 16 mi. north of Mazatlán, 1 ♂ 24-x; Mazatlán, 1 ♀ 24-x; Urías, 2 mi. south of Mazatlán, 1 ♂ 31-x; 2 mi. east of Concordia, 1 ♂ 25-x.

Urbanus chales (Godman and Salvin), 1893.

This species is thus far known only from western Mexico (Evans, 1952: 98). It is not common in collections.

SINALOA: 19 mi. east of Concordia, 1 ♂ 25-x, 1-xi.

Astraptes fulgerator azul (Reakirt), 1866.

A. f. azul is the subspecies of this attractive skipper found in Mexico, Central America, and western South America. It has been recorded from southern Texas. This species is another that has not been taken in Baja California.

SINALOA: Mazatlán, 1 ♂ 24-x; 19 mi. east of Concordia, 2 ♂ 26-x.

Achalarus albociliatus albociliatus (Mabille), 1877.

The nominate subspecies occurs from Mexico to Costa Rica, but it has not been recorded from the peninsula.

SINALOA: 16 mi. north of Mazatlán, 1 ♂ 29-x; Mazatlán, 1 ♀ 24-x; Urías, 2 mi. south of Mazatlán, 1 ♂ 1 ♀ 31-x; 17 mi. east of Concordia, 1 ♂ 1-xi.

Achalarus toxeus (Plötz), 1882.

This "species" is in a confused state. Evans (1952: 128, pl. 21) describes and presents five different genitalic configurations (poorly drawn) of the valva with the comment, "The cuiller of the clasp varies considerably, as specified in the list of the B. M. material. But the differences seem to be individual rather than sub-specific." In my opinion these differences are possibly specific, but the material available is not sufficient for definitive determinations. Significant results might be obtained by rearing through a few broods of these butterflies to see whether or not various configurations of the valva might occur in siblings. The material at hand from Sonora and Sinaloa either agrees with the figure of the genitalia given in Lindsey, Bell and Williams (1931: pl. 5, fig. 7, as *coyote*) or the valva is more pointed than in that figure. From Evans's figures it is difficult to determine which of his groups are represented in our material, but probably groups D and E are. All the males have well-defined costal folds and apical hyaline spots; the female lacks the apical spots.

SONORA: Hermosillo, 1 ♂ 20-x.

SINALOA: Mazatlán, 2 ♂ 24-x; Urías, 2 mi. south of Mazatlán, 1 ♂ 1 ♀ 31-x.

Thorybes valeriana (Plötz), 1882.

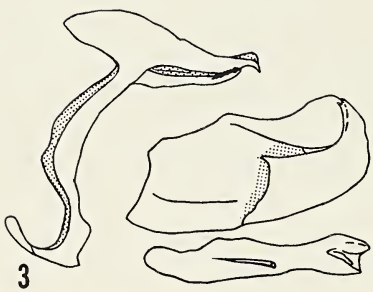
Figs. 1, 2 (♂), 3 (♂ genitalia).

Two ragged males of this species (determined by C. Don MacNeill) were taken on the peninsula and represent the first records from Baja California. These skippers are too worn to be compared profitably with mainland material and must be referred simply to *valeriana* at present. Evans (1952: 132) synonymizes the Dyar names *mysie* and *uvydixa* to *valeriana*, but MacNeill (*in litt.*) expresses some doubt as to the validity of Evans's conclusion. Much more material is necessary before any decisions can be made on these names.

BAJA CALFORNIA SUR: 4 mi. south of Arroyo Candelaria, 2 ♂ 26-x.







Figs. 1-3. All *Thorybes valeriana* (Plötz), ♂, Arroyo Candelaria, Baja California Sur, Mexico, 26-x-1961. Fig. 1, upper side : Fig. 2, under side; Fig. 3, ♂ genitalia.

Cabares potrillo potrillo (Lucas), 1857.

The nominate subspecies is found from southern Texas to Costa Rica, and in the West Indies. It is unrecorded from the peninsula.

SINALOA: 48 mi. northwest of Culiacán, 2♂ 1♀ 23-x; 16 mi. north of Mazatlán, 1♀ 29-x.

Celaenorrhinus fritzgaertneri fritzgaertneri Bailey, 1880.

This species occurs on the continent from southern Texas to Costa Rica (Evans, 1952: 165).

SINALOA: 17 mi. east of Concordia, 1♀ 1-xi.

Cogia hippalus hippalus (Edwards), 1882.

Two specimens of this subspecies were taken by the mainland party. They are distinct from the subspecies *peninsularis* represented in the Cape region and described previously (Miller and MacNeill, 1969: 20-21). MacNeill (1962) mentions the possibility that the nominate subspecies may occur on the peninsula in the San Pedro Mártir massif, Baja California Norte, but it has not been recorded to date.

SINALOA: 16 mi. north of Mazatlán, 1♂ 28-x; Urías, 2 mi. south of Mazatlán, 1♂ 31-x

Cogia hippalus peninsularis Miller and MacNeill, 1969.

This subspecies is restricted to the Cape region, as far as known. The records and characteristics are given in the original description (Miller and MacNeill, 1969: 20-21).

Cogia calchas (Herrich-Schäffer), 1869.

This species is one of the commonest in the Neotropics, but it is unrecorded from the peninsula. I have found it more commonly in disturbed areas, rather than in forest.

SINALOA: 17 mi. east of Concordia, 1 ♂ 1-xi.

Arteurotia tractipennis tractipennis Butler and Druce, 1872.

This species is widespread on the Mexican and Central American mainland.

SINALOA: 16 mi. north of Mazatlán, 3 ♂ 1 ♀ 29-x.

Nisoniades rubescens (Möschler), 1876.

This species is widely distributed throughout the moister parts of the Neotropics, but it has not been reported from the peninsula.

SINALOA: Urías, 2 mi. south of Mazatlán, 1 ♀ 31-x; 19 mi. east of Concordia, 1 ♀ 1-xi.

Pellicia costimacula arina Evans, 1953.

The subspecies *arina* is the Central American representative of this widely spread Neotropical skipper. All the specimens taken on the Expedition were captured on the mainland.

SINALOA: Urías, 2 mi. south of Mazatlán, 1 ♂ 31-x; 5 mi. west of Concordia, 1 ♂ 2-xi.

Pellicia dimidiata dimidiata Herrich-Schäffer, 1870.

This is another widespread tropical species that has not been recorded from Baja California.

SINALOA: Urías, 2 mi. south of Mazatlán, 1 ♂ 31-x; 5 mi. west of Concordia, 1 ♂ 2-xi.

Noctuana noctua bipuncta (Plötz), 1884.

This, too, is a mainland species; the subspecies *bipuncta* is known from Mexico to Nicaragua.

SINALOA: 19 mi. east of Concordia, 1 ♂ 1-xi.

Noctuana stator (Godman and Salvin), 1899.

This is another mainland species that does not reach the peninsula.

SINALOA: 19 mi. east of Concordia, 2♂ 1♀ 25-x.

Bolla phylo pullata (Mabille), 1878.

This Central American butterfly is represented in the Expedition collection by a single female which is provisionally placed here.

SINALOA: 19 mi. east of Concordia, 1♀ 25-x.

Bolla clytius (Godman and Salvin), 1897.

This uncommon species is thus far known only from western continental Mexico and Honduras (Evans, 1953: 83).

SONORA: 12 mi. south of Hermosillo, 2♂ 20-x; 36 mi. north of Guaymas, 2♂ 20-x.

SINALOA: 46 mi. north of Los Mochis, 1♂ 22-x; 48 mi. northwest of Culiacán, 1♂ 1♀ 23-x.

Staphylus ceos (Edwards), 1882.

This species is basically a member of the Sonoran desert fauna that has also penetrated Baja California. I can detect no difference between the peninsular and mainland populations.

On the peninsula *ceos* was rather widely distributed, though never abundant. It generally sought the shadiest places available and seldom ventured far from them, at least during the hours of hot sunlight — I never saw it in the early morning or late afternoon. This species may be taken occasionally at water.

BAJA CALIFORNIA SUR: Rancho El Novillo, 2♂ 28-x; Rancho Palmarito, 1♂ 27-x, 1♂ 4-xii; Arroyo San Bartolo, 1♂ 2♀ 2-xi; Bahía de Palmas, 1♂ 16-xi; roadway 5 kilometers south of Rancho Buenavista, 1♀ 25-x; Boca de la Sierra, 1♀ 13-xi, 2♂ 24-xi; Arroyo Candelaria, 1♂ 26-x; 4 mi. south of Arroyo Candelaria, 1♂ 1♀ 24-xi.

SONORA: 16 mi. south of Guaymas, 1♂ 21-x.

Staphylus mazans mazans (Reakirt), 1866.

These specimens seem to be referable to typical *mazans* (type-locality: near Veracruz, Mexico), not to *ascaphalus* (Staudinger). The various subspecies, if subspecies they are, of *mazans* seem to replace *ceos* in the more humid parts of Mexico.

SINALOA: 48 miles northwest of Culiacán, 2♀ 23-x; 16 mi. north of Mazatlán, 3♂ 29-x; 5 mi. west of Concordia, 1 ♀ 2-xi; 19 mi. east of Concordia, 2♂ 1♀ 25-x.

Mylon pelopidas (Fabricius), 1793.

This is a moderately common skipper throughout the more humid parts of the Neotropics. It is not found on the peninsula.

SINALOA: 5 mi. west of Concordia, 1 ♂ 2-xi.

Mylon lassia (Hewitson), 1868.

This species is found on the mainland from Mexico to northern South America.

SINALOA: 19 mi. east of Concordia, 1 ♀ 1-xi.

Antigonus erosus (Hübner), 1812.

This is a widespread continental Neotropical species.

SINALOA: 48 mi. northwest of Culiacán, 2 ♀ 23-x.

Systasea zampa (Edwards), 1876.

Hesperia zampa Edwards, 1876. Trans. Amer. Ent. Soc., 5: 207 (type-locality: South Apache, Arizona).

Antigonus evansi Bell, 1941. Ent. News, 52: 165; fig. 2 (type-locality: Baboquivari Mts., Arizona). New synonomy.

Figs. 4, 5 (Neotype ♂), 6 (Neotype ♂ genitalia).

Edwards (1876: 207) described *Hesperia zampa* from a single example collected at "South Apache, Arizona" and retained it in his own collection. Later he sent this specimen and several others to Speyer for study (Brown, 1964). This shipment of butterflies was lost when the S. S. *Pomerania* went down in the English Channel, so it is apparent that the type of *zampa* was lost.

Holland (1931: pl. 46, fig. 1) wrote the next chapter in the history of this name by figuring a specimen of S. *pulverulenta* (Felder) as the "type" of *zampa*. As noted above, that specimen cannot be the authentic holotype of *zampa*, and was not even from the Edwards collection. It bears only the printed labels, "Arizona" and "Holland/Collection." The Holland designation of the identity of *zampa*, however, was accepted by many subsequent authors, notably Bell (1941: 164) and Evans (1953: 160). Both placed *zampa* in the synonymy of *pulverulenta*, justifiably if the specimen figured by Holland were the holotype of *zampa*. Bell (1941: 165) then described the second species of the genus occurring in North America as *Antigonus evansi*.

Inasmuch as Bell and Evans have successfully separated these two species, I am reluctant to upset current nomenclature. I have discussed

the status of the present species with several colleagues who have had extensive field experience in Arizona, and while all of us have seen hundreds of examples of this skipper, none of us has seen an unquestionably authentic specimen of *pulverulenta* from that state. The few specimens that bear data other than the vague "Arizona" of earlier collectors are specimens taken by O. C. Poling that are labeled as from the Baboquivari Mountains. Poling, a professional collector, also collected extensively in the Davis Mountains, Texas (where *pulverulenta* occurs), and he was not overly careful with his data. So I suspect that at least some of the specimens he labeled as from Arizona were actually collected in Texas. Since I can find no authentic *pulverulenta* from Arizona, and since there are two specimens of "*evansi*" from Arizona in the Edwards collection, I reluctantly designate one of the latter as the neotype of *Hesperia zampa* Edwards. This specimen bears labels as follows: first, a handwritten label, "Zampa ♂/Edw. Ariz[a].";" second, a printed label, "Edwards/Collection"; and third, a partly printed, partly handwritten label, "Neotype/Hesperia/zampa ♂/W. H. EDWARDS/ designated by/Lee D. Miller, 1965." The designation of this specimen has been done with the knowledge and encouragement of F. Martin Brown, who is engaged in a complete study of the Edwards types.

The present species is well differentiated by Bell (1941: 164-166) and Evans (1953: 160), as *evansi*, and these works should be consulted for a complete listing of the distinguishing characteristics.

H. zampa is a desert or subdesert species, whereas *pulverulenta* occurs in less arid situations. We found the present species around watering places where it flew close to the ground, rarely visited flowers and lighted with the wings half open. These skippers were never particularly abundant.

The Expedition records are as follows:

BAJA CALFORNIA SUR: Rancho Palmarito, 4♂ 2♀ 27-x, 1♂ 31-x, 3♂ 1♀ 4-xi, 3♂ 1♀ 5-xi, 8♂ 2♀ 30-xi.

SONORA: 12 mi. south of Hermosillo, 3♂ 20-x; 10 mi. northwest of Caborca, 1♂ 1♀ 19-x.

Systasea pulverulenta (Felder), 1869.

Fig. 7 (♂ genitalia).

Evans (1953: 160) lists specimens from Arizona, Texas, Mexico, and Guatemala but, as indicated in the discussion of *zampa*, the records of



Figs. 4-7. *Systasea zampa* (Edwards), neotype ♂, "Arizona," upper side. Fig. 5, same, under side. Fig. 6, same, ♂ genitalia. Fig. 7, *S. pulverulenta* (Felder), ♂ genitalia.

the present species from Arizona are apparently based on erroneous data.

All specimens taken by Expedition personnel were collected on the mainland.

SONORA: 16 mi. south of Navojoa, 1 ♂ 22-x.

SINALOA: 16 mi. north of Mazatlán, 1 ♂ 29-x; Urías, 2 mi. south of Mazatlán, 1 ♂ 31-x; 4 mi. southeast of Mazatlán, 1 ♂ 25-x.

Zopyrion sandace Godman and Salvin, 1896.

This species is found in the moderately humid parts of Mexico and Guatemala.

SINALOA: 48 mi. northwest of Culiacán, 1 ♂ 23-x; 16 mi. north of Mazatlán, 1 ♂ 29-x; Urías, 2 mi. south of Mazatlán, 9 ♂ 3 ♀ 29-x; 17 mi. east of Concordia, 2 ♂ 1-xi.

Achylodes thraso tamenund (Edwards), 1870.

I am retaining the Edwards name *tamenund* for the Texas and Mexican material, although Evans (1953: 177) synonymized it to the nominate race. It is an exclusively mainland subspecies, and there are three West Indian ones.

SINALOA: 16 mi. north of Mazatlán, 2♂ 2♀ 29-x.

Achylodes selva Evans, 1953.

This species seems to be restricted to the higher, subtropical moist forests of the Neotropics.

SINALOA: 19 mi. east of Concordia, 1♂ 25-x.

Timochares ruptifasciata ruptifasciata (Plötz), 1884.

This is another mainland Mexican species.

SINAOLA: Mazatlán, 1♂ 28-x.

Anastrus sempiternus sempiternus (Butler and Druce), 1872.

This species is another from the mainland.

SINALOA: Mazatlán, 1♂ 26-x, 1♂ 27-x, 2♂ 29-x.

Anastrus tolimus tolimus (Plötz), 1884.

This, too, is a species found on the mainland only.

SINALOA: Mazatlán, 1♀ 27-x, 1♂ 3-xi.

Chiomara asychis georgina (Reakirt), 1868.

This subspecies is the one represented in the southernmost United States, Mexico, and Central America. Evans (1953: 198) considers the Baja California material to be the same subspecies, as does MacNeill (1962: 100), but the peninsular specimens are consistently so different from mainland ones that the Weeks name *pelagica* (see below) is resurrected for them.

SONORA: Hermosillo, 1♂ 1♀ 20-x; 12 mi. south of Hermosillo, 3♂ 20-x; 36 mi. north of Guaymas, 1♂ 20-x.

SINALOA: 46 mi. north of Los Mochis, 2♂ 22-x; 19 mi. north of Los Mochis, 1♂ 22-x; 17 mi. east of Concordia, 1♂ 1-xi; 22 mi. east of Concordia, 2♂ 25-x.

Chiomara asychis pelagica (Weeks), 1891.

The peninsular *asychis* are very different from the mainland representatives of this species, hence I am restoring the Weeks name *pelagica* to them. This subspecies most closely resembles Argentinian

and Bolivian specimens of *C. a. autander* (Mabille) and bears little resemblance to the Mexican and Central American *georgina*. The differences between *georgina* and *pelagica* are summarized in Table 2.

TABLE 2

Chiomara asychis: DIFFERENTIATING CHARACTERS OF THE SUBSPECIES *georgina* (MEXICAN MAINLAND) AND *pelagica* (BAJA CALIFORNIA)

georgina	*pelagica*
1. ♂ ♀ paler above.	1. ♂ ♀ darker above.
2. Discal spot in forewing space Cu_2-2A always white.	2. Discal spot in forewing space Cu_2-2A often gray, never white in ♀.
3. Hindwing white discal band broad and well developed.	3. Hindwing white discal band narrow, often broken and obsolete in ♀.
4. Sexual dimorphism slight.	4. Sexual dimorphism marked.
5. ♀ hindwing below with little basal and discal brown mottling.	5. ♀ hindwing below with prominent basal and discal brown mottling.

These butterflies were common almost everywhere on the peninsula where collecting was done. They do not visit flowers as avidly as do some of the other skippers and are more likely to be seen sunning themsleves on the tips of twigs with their wings outstretched. They are not particularly pugnacious, although they may on occasion attack almost anything that moves in their vicinity. The silhouette of these butterflies at rest is characteristic: the wings are held outstretched and the tips of the forewings droop, giving the butterflies a convex appearance.

BAJA CALIFORNIA SUR: La Paz, Hotel Guaycura grounds, 1♂ 21-x, 1♂ 1♀ 6-xi; 28-x; Rancho Palmarito, 3♂ 1♀ 27-x, 1♂ 30-x, 4♂ 2♀ 31-x, 4♂ 4-xi, 1♀ 5-xi, 9♂ 6♀ 30-xi, 5♂ 4-xii; Arroyo Hondo, near El Triunfo, 3♂ 24-x; Mesa Puerta Azul, 1♂ 1♀ 12-xi; Arroyo San Bartolo, 2♂ 1♀ 2-xi, 2♂ 3-xi, 2♂ 12-xi, 1♂ 14-xi; roadway 5 kilometers south of Rancho Buenavista, 3♀ 25-x; Arroyo San Bernardo, 1♂ 18-xi; Arroyo El Rincón, 2♀ 26-xi; San José del Cabo, 5♂ 5♀ 22-xi, Puerto Chileno, 2♂ 2♀ 22-xi, 1♂ 26-xi; Arroyo Candelaria, 4♂ 24-xi; 4 mi. south of Arroyo Candelaria, 3♂ 1♀ 26-x, 2♂ 3♀ 24-xi.

Two additional specimens have been examined in the collection of the San Diego Museum of Natural History.

BAJA CALFORNIA SUR: San Bartolo, 1♂ 24-xi-1959; Las Parras, 1♂ 14-xi-1961 (C. F. Harbison).

Gesta gesta invisus (Butler and Druce), 1872.

The present subspecies is represented on the mainland from southern Texas to Costa Rica.

SINALOA: 16 mi. north of Mazatlán, 1♀ 29-x; Mazatlán, 1♂ 24-x, 1♂ 2♀ 28-x; 19 mi. east of Concordia, 4♂ 1♀ 25-x.

Erynnis funeralis (Scudder and Burgess), 1870.

I am following Burns (1964) in attributing specific rank to *funeralis*, but most authors have considered it a subspecies of *zarucco* (Lucas).

This species is one of the most distinctive elements of the Sonoran desert fauna, and it is common in Baja California. In sharp contrast to most of the skippers, *funeralis* is to be found even in the very dry desert and in the brightest, hottest sunshine. It is very pugnacious and will engage in mock combat with almost anything that moves. It visits flowers frequently, showing a particular preference for the flowers of large yellow composites.

BAJA CALIFORNIA SUR: La Paz, Hotel Guaycura grounds, 2♂ 2♀ 6-xi, 1♂ 8-xi; Rancho Rosarito, 5♂ 3♀ 23-x; southwest shore of La Paz harbor, 2♂ 8-xi, 2♂ 1♀ 10-xi, 1♂ 5-xii, 1♂ 6-xii; Rancho Vinorama, 1♂ 23-x; Rancho El Novillo, 2♂ 28-x; Rancho Palmarito, 1♂ 27-x, 1♂ 31-x, 2♂ 4-xi, 5♂ 30-xi; Mesa Puerta Azul, 2♂ 1-xi; Arroyo San Bartolo, 2♂ 2-xi, 3♂ 1♀ 3-xi, 1♀ 12-xi; Bahía de Palmas, 1♀ 12-xi; road 5 kilometers south of Rancho Buenavista, 1♂ 1♀ 25-x; Miraflores, 1♀ 25-x; La Ciénaga I, 1270 m., 1♂ 1♀ 16-xi; Puerto Chileno, 1♂ 22-xi; Cabo San Lucas, 1♂ 23-xi; Arroyo Candelaria, 1♂ 24-xi, 1♀ 26-x; 4 mi. south of Arroyo Candelaria, 1♀ 24-xi.

BAJA CALIFORNIA NORTE: 21 mi. south of Mexicali, 1♂ 17-x.

SONORA: 10 mi. northwest of Caborca, 2♂ 19-x; 12 mi south of Hermosillo, 2♂ 2♀ 20-x; 26 mi. north of Guaymas, 1♀ 20-x.

SINALOA: 48 mi. northwest of Culiacán, 1♂ 23-x.

Ten additional specimens have been examined from the collection of the San Diego Museum of Natural History.

BAJA CALIFORNIA SUR: Las Parras, 1♀ 19-xi-1952; Colonia Calles, 1♀ 15-ix-1959.

BAJA CALIFORNIA NORTE: Valle de la Trinidad, 2♂ 16-iii-1936; Santo Tomás, 2♂ 1♀ 20-iii-1935, 1♂ 16-ix-1935; Santa Agueda, 1♂ 16-ix-1935 (all C. F. Harbison).

Erynnis tristis pattersoni Burns, 1964.

This subspecies was originally described from seven males collected in the Sierra de la Laguna (sometimes called Sierra de la Victoria). The genitalia of the two males taken by the Expedition look more like those of *E. tristis tatius* (Edwards) than those of the nominate subspecies. These two specimens were taken at the top of a windswept grassy hill at an elevation of 1270 meters. Oaks were plentiful nearby; these are postulated as the food plant by Burns (1964: 143). Since the type series was taken in May and the Expedition material was collected in November, this species is at least double-brooded in the Cape region.

BAJA CALIFORNIA SUR: La Ciénega, I, Sierra Laguna, 1270 m., 2♂ 15-xi.

Pyrgus communis albescens Plötz, 1884.

This is another of the Sonoran desert species that has become successfully established throughout the peninsula. Its habits are quite similar to those shown by other *communis* populations throughout the United States and Mexico.

BAJA CALIFORNIA SUR: Southeast shore of La Paz harbor, 1 ♀ 10-xi; Rancho Palmarito,, 3 ♂ 2 ♀ 27-x, 3 ♂ 4 ♀ 31-x, 7 ♂ 5 ♀ 4-xi, 4 ♂ 2 ♀ 5-xi, 5 ♂ 2 ♀ 20-xi; Mesa Puerta Azul, 1 ♂ 1-xi; Arroyo San Bartolo, 1 ♂ 12-xi; Bahía de Palmas, 1 ♂ 20-xi; Rancho San Bernardo, 1 ♂ 17-xi; Caduaño, 1 ♂ 25-xi; Arroyo Candelaria, 2 ♂ 24-xi; 4 mi. south of Arroyo Candelaria, 1 ♂ 26-x.

Three additional specimens have been examined from the collection of the San Diego Museum of Natural History.

BAJA CALIFORIA SUR: Comondú, 2 ♂ 16-xii-1956.

BAJA CALIFORNIA NORTE: Santa María, 1 ♂ 23-viii-1953 (C. F. Harbison).

Pyrgus oileus oileus (Linné), 1767.

This subspecies is widespread throughout Mexico, Central America, and the Antilles, but it has not been previously recorded from Baja California. A single male in the Expedition material from the Cape region represents the first record from the peninsula of this species.

BAJA CALIFORNIA SUR: Rancho Palmarito, 1 ♂ 30-xi.

SONORA: 16 mi. south of Navojoa, 1 ♀ 22-x.

SINALOA: 48 mi. northwest of Culiacán, 2 ♂ 4 ♀ 23-x; 16 mi. north of Mazatlán, 1 ♂ 28-x, 1 ♂ 29-x; Mazatlán, 1 ♂ 1 ♀ 24-x; Urias, 2 mi. south of Mazatlán, 1 ♂ 2 ♀ 31-x; 19 mi. east of Concordia, 5 ♂ 5 ♀ 25-x; 17 mi. east of Concordia, 1 ♀ 29-x, 3 ♀ 1-xi; 2 mi. east of Concordia, 2 ♂ 25-x.

Pyrgus philetas Edwards, 1881.

I agree entirely with MacNeill (1962: 101), who has reinstated *philetas* as a distinct species. Evans (1953: 222) had placed it as a subspecies of *oileus*. The present species is characteristic of the Sonoran and Chihuahuan desert and is found in the Cape region of Baja California.

This skipper was found wherever there was water, though it was seldom abundant. It visits flowers and is particularly fond of those of the "desert willow." Many other specimens were collected at mud puddles. *P. philetas* seems to be more widespread throughout the Cape region than *albescens*, but is not as common as that species in areas where both are present.

BAJA CALIFORNIA SUR: Rancho Palmarito, 2 ♂ 27-x; 1 ♀ 30-x, 1 ♂ 2 ♀ 31-x, 3 ♀ 4-xi, 2 ♂ 1 ♀ 5-xi; Rancho Vinorama, 1 ♂ 23-x; Arroyo Hondo, near El Triunfo, 1 ♂

24-x; Mesa Puerta Azul, 1♂ 1-xi; Arroyo San Bartolo, 1♂ 2-xi, 1♂ 3-xi; Bahía de Palmas, 1♀ 20-xi; roadway 5 kilometers south of Rancho Buenavista, 3♂ 25-x; Boca de la Sierra, 2♂ 13-xi, 1♂ 24-xi; Arroyo San Bernardo, 2♂ 18-xi; Rancho San Bernardo, 500-600 m., 1♂ 17-xi; La Ciénaga I, Sierra Laguna, 1270 m., 1♂ 1♀ 16-xi; Arroyo El Rincón, 1♂ 1♀ 26-xi; San Jose del Cabo, 1♂ 2♀ 25-xi; Arroyo Candelaria, 2♀ 26-x; 1♂ 24-xi; 4 mi. south of Arroyo Candelaria, 1♂ 26-x, 2♂ 24-xi.

SONORA: 12 mi. south of Hermosillo, 2♂ 2♀ 20-x.

SINALOA: Urías, 2 mi. south of Mazatlán, 2♂ 31-x.

Heliopetes domicella domicella (Erichson), 1848.

This subspecies is found infrequently from Texas and Arizona south to northern South America. A few specimens have been recorded previously from the peninsula.

This butterfly was never common and was taken only in several arroyos, although at Rancho Palmarito I saw a specimen or two that eluded me. Generally they were seen flying about in moderate shade or visiting low flowers. Unlike many of their relatives, these butterflies are very inconspicuous in the field. They are not combative, in contrast to most Mexican *Heliopetes*.

The single female from south of Hermosillo is a striking aberration, differing from the ordinary female in the following particulars: the apical-submarginal row of white spots on the forewing, both above and below, is fused into a band that is connected to the discal white band, leaving a subtriangular black patch at the end of the forewing cell. The hind wing pattern is more or less normal, perhaps showing the white discal band a bit more developed.

BAJA CALIFORNIA SUR: Arroyo San Bartolo, 1♂ 3-xi, 1♂ 12-xi; roadway 5 kilometers south of Rancho Buenavista, 1♂ 25-v; Arroyo San Bernardo, 1♂ 18-xi.

SONORA: La Zorra, 10 mi. northwest of Caborca, 1♂ 1♀ 19-x; 12 mi. south of Hermosillo, 3♂ 1♀ 20-x.

SINALOA: 16 mi. north of Mazatlán, 1♀ 28-x; 5 mi. west of Concordia, 1♀ 2-xi.

Heliopetes macaira macaira Reskirt, 1866.

This species has not been found on the peninsula. The nominate subspecies is moderately common from Texas to Panama.

SINALOA: 48 mi. northwest of Culiacán, 2♂ 23-x; Mazatlán, 2♀ 24-x; Urías, 2 mi. south of Mazatlán, 2♂ 31-x.

Heliopetes laviana laviana (Hewitson), 1868.

This widespread tropical species is common in the Cape region of Baja California.

Almost wherever there is water, natural or otherwise, *laviana* is abundant. These butterflies are avid flower visitors, preferring the flowers of low composites or leguminous plants. Otherwise the males will establish territories and attempt mock combat with other members of their species, but they are not as pugnacious as some of the "long-tails."

BAJA CALIFORNIA SUR: Rancho Rosarito, 2♂ 1♀ 23-x; Rancho El Novillo, 1♀ 28-x; Rancho El Salto, 1♀ 28-x; Rancho Palmarito, 2♀ 27-x, 3♂ 2♀ 31-x, 2♂ 4-xi; 21♂ 4♀ 30-xi; Arroyo Hondo, near El Triunfo, 2♂ 24-x; Arroyo San Bartolo, 1♂ 12-xi; roadway 5 kilometers south of Sancho Buenavista, 1♂ 25-x; Miraflores, 1♂ 25-x; Boca de la Sierra, 1♂ 28-xi; Arroyo El Rincón, 1♀ 26-xi; Puerto Chileno, 1♀ 22-xi; Arroyo Candelaria, 1♂ 24-xi; 4 mi. south of Arroyo Candelaria, 2♂ 24-xi.

SINALOA: 46 mi. north of Los Mochis, 9♂ 22-x; 19 mi. north of Los Mochis, 1♂ 23-x; 48 mi. northwest of Culiacán, 1♂ 23-x; 16 mi. north of Mazatlán, 1♂ 24-x; 17 mi. east of Concordia, 1♂ 1-xi; 19 mi. east of Concordia, 1♀ 25-x; 19 mi. east of Concordia, 1♀ 25-x; 17 mi. east of Concordia, 1♂ 1-xi.

Pholisora catullus (Fabricius), 1793.

This species is primarily North American, but is also known from northern Sonora and from scattered localities along the Baja California peninsula where it is not common.

BAJA CALIFORNIA SUR: La Paz, Hotel Guaycura grounds, 2♂ 21-x, 1♀ 22-x; Rancho Palmarito, 1♂ 27-x; roadway 5 kilometers south of Rancho Buenavista, 1♀ 25-x; Arroyo El Rincón, 1♂ 26-xi; 4 mi. south of Arroyo Candelaria, 1♂ 26-x.

Three additional specimens have been examined from the collection of the San Diego Museum of Natural History.

BAJA CALIFORNIA NORTE: Valle de la Trinidad, 1♂ 16-iii-1936; Santo Tomés, 2♂ 20-iii-1935 (C. F. Harbison).

Callimormus saturnus (Herrich-Schäffer), 1869.

This skipper is common throughout the humid portions of the Neotropics.

SINALOA: 16 mi north of Mazatlán, 1♀ 29-x; 11 mi. north of Mazatlán, 1♂ 27-x, 1♂ 28-x; 19 mi. east of Concordia, 1♂ 1♀ 25-x, 1♀ 1-xi.

Subfamily HESPIINAE

Monca telata tyrtaeus (Plötz), 1883.

This subspecies is moderately common in Mexico and Central America. It is not known from the peninsula.

SINALOA: Mazatlán, 2♂ 24-x.

Nastra neamathla (Skinner and Williams), 1923.

This species was first recorded from the peninsula by MacNeill (1962: 103-104), who reported specimens from Canyon San Pedro in the Sierra de la Laguna of the Cape region. The specimens listed below indicate that *neamathla* may actually be widely distributed throughout the Cape region, but it is apparently never common. With the abundance of *Lerodea e. eufala* (Edwards), however, it may have been overlooked by most collectors, since the two have rather similar habits.

BAJA CALIFORNIA SUR: Rancho Palmarito, 1 ♂ 4-xii; Arroyo San Bartolo, 1 ♂ 1 ♀ 2-xi; San José del Cabo, 1 ♂ 23-xi.

Cymaenes odilia trebius (Mabille), 1891.

Two specimens of this species were taken by the mainland party.

SINALOA: 5 mi. west of Concordia, 1 ♂ 2-xi; 19 mi. east of Concordia, 1 ♀ 1-xi.

Vehilius inca (Scudder), 1872.

This species is common in the continental Neotropics.

SINALOA: 17 mi east of Concordia, 1 ♂ 1-xi; 19 mi. east of Concordia, 1 ♀ 25-x, 1 ♂ 1 ♀ 1-xi.

Lerema lumina (Herrich-Schäffer), 1869.

Evans (1955: 163) records this species only from Guatemala, Costa Rica, Panama, and Colombia, but I have seen specimens from Mexico. The specimen listed below is the first I am aware of from so far north on the west coast.

SINALOA: Mazatlán, 1 ♂ 28-x.

Lerema accius accius (Abbot and Smith), 1797.

This subspecies is common in the southern United States and Mexico and occurs more infrequently in Central America. It has not been reported from the peninsula.

SONORA: Hermosillo, 1 ♂ 1 ♀ 20-x.

SINALOA: Mazatlán, 1 ♂ 29-x; 2 mi. east of Concordia, 1 ♂ 1 ♀ 25-x; 19 mi. east of Concordia, 1 ♂ 25-x.

Vettius fantasos fantasos (Stoll), 1780.

This species is common in the humid parts of the Neotropics, but seems to be absent from arid or semi-arid regions.

SINALOA: 48 mi. northwest of Culiacán, 1 ♂ 1 ♀ 23-x.

Ancyloxypha arene (Edwards), 1871.

This species replaces *numitor* (Fabricius) in the southwestern United States, Mexico, and Central America. It has not been recorded from the peninsula, but there is the barest possibility it may occur in suitable habitats in the northern part near the mouth of the Colorado River.

SONORA: 16 mi. south of Navojoa, 1 ♂ 22-x; 16 mi. south of Guaymas, 2 ♀ 21-x.

SINALOA: 48 mi. northwest of Culiacán, 1 ♂ 1 ♀ 23-x; Mazatlán, 1 ♂ 31-x.

Copaeodes aurantiaca (Hewitson), 1868.

This species and the next tend to replace one another, *aurantiaca* being far more abundant in the very arid regions, while *minima* is commoner in more humid environments. The present species is found in the southwestern United States and western Mexico, including the peninsula.

C. aurantiaca was present in almost all areas of the peninsula visited by the Expedition, even in some of the driest arroyos. It does not visit flowers as readily as most of the skippers, but when it does, it prefers large yellow composites. Most of the time, however, it perches on a rock or a twig and waits for other butterflies, with whom it engages in mock combat.

BAJA CALIFORNIA SUR: La Paz, Hotel Guaycura grounds, 1 ♂ 21-x, 1 ♂ 22-x; 5 mi. east of La Paz, 2 ♀ 9-xi; southeast shore of La Paz harbor, 1 ♂ 1 ♀ 8-xi; Rancho Rosarito, 3 ♂ 1 ♀ 23-x; Rancho Vinorama, 1 ♀ 23-x; Rancho El Novillo, 2 ♂ 28-x; Rancho Palmarito, 3 ♂ 1 ♀ 27-x, 3 ♂ 31-x, 1 ♀ 4-xi, 3 ♂ 1 ♀ 5-xi, 2 ♂ 1 ♀ 30-xi, 1 ♂ 1 ♀ 4-xii; Mesa Puerta Azul, 3 ♂ 24-x, 1 ♂ 25-x, 1 ♂ 1-xi, 2 ♂ 2-xi, 1 ♂ 12-xi; Arroyo San Bartolo, 1 ♂ 2-xi, 2 ♂ 3-xi; Miraflores, 1 ♂ 25-x; Boca de la Sierra, 2 ♂ 2 ♀ 24-xi, 4 ♂ 28-xi; Rancho San Bernardo, 1 ♂ 14-xi; San José del Cabo, 1 ♂ 22-xi; Puerto Chileno, 2 ♂ 22-xi; 4 mi. south of Arroyo Candelaria, 2 ♂ 24-xi.

SONORA: 12 mi. south of Hermosillo, 1 ♂ 2 ♀ 20-x; 36 mi. south of Guaymas, 1 ♂ 20-x.

SINALOA: Mazatlán, 1 ♀ 24-x.

Two additional specimens have been examined from the collection of the San Diego Natural History Museum.

BAJA CALIFORNIA NORTE: Valle de la Trinidad, 1 ♂ 16-iii-1936; Santa Agueda, 1 ♂ 16-ix-1935.

Copaeodes minima (Edwards), 1870.

This species occurs in moist to semi-arid areas from the southern United States to Costa Rica. It has not been reported from the peninsula.

SINALOA: Mazatlán, 1 ♀ 24-x, 4 ♂ 2 ♀ 26-x, 1 ♀ 29-x, 1 ♂ 31-x; Urías, 2 mi. south of Mazatlán, 1 ♀ 31-x.

Hylephila phyleus phyleus (Drury), 1770.

This species, one of the most widespread in the Neotropics, penetrates the temperate regions to the north and south. It is common on the peninsula.

H. phyleus is an avid flower visitor and almost any cultivated flower garden on the peninsula swarmed with these butterflies. Even when they are visiting flowers, these butterflies are always ready to engage another butterfly, a bird, or a butterfly collector in mock combat. They are easily captured when they are visiting blossoms, but otherwise these skippers are extremely wary.

BAJA CALIFORNIA SUR: La Paz, Hotel Guaycura grounds, 1- 20-x, 8♂ 2♀ 21x, 1♀ 7-xi; southeast shore of La Paz harbor, 4♂ 8♀ 8-xi, 2♂ 3♀ 10-xi, 1♂ 5-xii; Rancho Palmarito, 1♀ 31-x, 2♂ 4-xi, 1♀ 5-xi; Mesa Puerta Azul, 1♂ 24-x; Arroyo San Bernardo, 1♂ 17-xi; San José del Cabo, 2♀ 23-xi, 3♀ 25-xi; Arroyo Candelaria, 1♂ 2♀ 26-x.

SONORA: 5 mi. west of Riito, 1♀ 17-x; 16 mi. south of Guaymas, 1♂ 21-x, 1♂ 22-x.

SINALOA: Mazatlán, 1♂ 26-x; Urías, 2 mi. south of Mazatlán, 1♂ 1♀ 31-x; 5 mi west of Concordia, 1♂ 2-xi.

Two other specimens from the collection of the San Diego Natural History Museum have been examined.

BAJA CALIFORNIA SUR: Commondú, 1♀ 16-xi-1956.

BAJA CALIFORNIA NORTE: El Barril, 1♀ 14-iii-1947 (C. F. Harbison).

Yvretta carus subreticulata (Plötz), 1883.

A single small, rather dark female of this subspecies was taken by the mainland party. I am indebted to Dr. C. Don MacNeill for identifying the specimen. Thus far *subreticulata* is known from western Mexico and Guatemala; it does not appear to be common.

SINALOA: Mazatlán, 1♀ 24-x.

This subspecies is widespread throughout the American tropics but has not been recorded from the peninsula.

SINALOA: 16 mi. north of Mazatlán, 1♀ 29-x; Mazatlán, 3♂ 24-x, 1♀ 27-x, 2♂ 28-x; Urías, 2 mi. south of Mazatlán, 2♂ 31-x; 22 mi. east of Concordia, 1♂ 25-x.

Polites sabuleti chusca (Edwards), 1873.

This is the subspecies found in the Sonoran desert. It almost certainly occurs in Baja California Norte, since the specimens taken by the mainland party were collected just across the Colorado River from that state.

SONORA: 5 mi. west of Riito, 1♂ 2♀ 17-x.

Polites sabuleti margaretae Miller and MacNeill, 1969.

This subspecies is known from only a few scattered coastal localities in the Cape region of Baja California Sur. The records and characteristics are given in the original description (Miller and MacNeill, 1969: 22-23).

Wallengrenia otho (Abbot and Smith), 1797, subspecies.

There are no records of *otho* from the peninsula. The mainland specimens more nearly resemble *curassavica* (Snellen) than nominate *otho*, but Evans (1955: 333) mentions only *otho* from Mexico. The nearest records cited for *curassavica* are from Panama. Much work needs to be done on the *otho* complex both on the mainland and in the Antilles, before we shall have a reasonable understanding of the subspecies involved.

SINALOA: Urías, 2 mi. south of Mazatlán, 1 ♀ 1-xi; 19 mi. east of Concordia, 1 ♀ 31-x.

Pompeius pompeius (Latreille), 1824.

This species is one of the commonest skippers in disturbed areas of the continental Neotropics. It is not known from the peninsula.

SINALOA: Mazatlán, 2 ♂ 1 ♀ 24-x; Urías, 2 mi. south of Mazatlán, 1 ♂ 1 ♀ 31-x; 17 mi. east of Concordia, 1 ♀ 25-x.

Atalopedes campestris (Boisduval), 1852.

This species is widespread throughout the United States, Mexico and Central America. It was common particularly in cultivated areas of Baja California Sur, where its habits are sustantially the same as in the United States.

BAJA CALIFORNIA SUR: La Paz, Hotel Guaycura grounds, 3 ♂ 2 ♀ 22-x, 2 ♀ 6-xi, 1 ♀ 7-xi, 1 ♂ 8-xi; southeast shore of La Paz harbor, 1 ♂ 8-xi, 6 ♂ 3 ♀ 10-xi; Rancho Palmarito, 1 ♀ 30-xi; Mesa Puerta Azul, 1 ♂ 1-xi; San José del Cabo, 1 ♀ 22-xi, 3 ♂ 1 ♀ 25-xi.

SINALOA: 19 mi. north of Los Mochis, 1 ♂ 22-x.

Mellana eulogius (Plötz), 1883.

This species is widespread throughout the Neotropics.

SINALOA: 16 mi. north of Mazatlán, 1 ♂ 29-x; Urías, 2 mi. south of Mazatlán, 1 ♂ 31-x.

Atrytonopsis ovinia zaovinia Dyar, 1913.

No *Atrytonopsis* has been recorded from the peninsula. The present subspecies is restricted to the Sonoran desert.

SONORA: Hermosillo, 1 ♂ 1 ♀ 20-x.

Amblyscirtes tolteca Scudder, 1872, ?subspecies.

The nominate subspecies is widely distributed in southern Mexico, and the subspecies *prenda* Evans is thus far known only from Tucson, Arizona; and Guaymas, Sonora. Rindge (1948: 309) recorded this skipper from the peninsula, but the specimen was not available for study by MacNeill, who concluded (1962: 111) that *tolteca* was "a doubtful inhabitant" of the peninsula. Expedition personnel collected a dozen specimens in scattered localities in the Cape region, so this species is definitely present in the peninsula. All these specimens are worn, however, and I have no specimens at hand of *prenda*, so I am unable to say which subspecies is represented by the Cape material. The specimens are generally a bit smaller than a series at hand from Pisté, Yucatán, but there is no evidence of the grayish flush Evans (1955: 389) employs to characterize *prenda*.

A. tolteca is not a common species, and its secretive habits would account for its being overlooked. It has a rapid flight and always remains close to the ground. It is not a pugnacious butterfly and is so unobtrusive that the collector must be especially observant to find specimens. The only flowers visited were those that grew close to the ground, such as coralvine.

BAJA CALIFORNIA SUR: La Paz, Hotel Guaycura grounds, 1♂ 19-x, 1♂ 21-x; Rancho Palmarito, 1♂ 27-x, 1♂ 31-x, 3♂ 1♀ 5-xi; Puerto Chileno, 1♂ 22-xi; Cabo San Lucas, 1♀ 23-xi, 1♀ 24-xi; 4 mi. south of Arroyo Candelaria, 1♂ [26-xi] (26-x).

Lerodea eufala eufala (Edwards), 1869.

This species is common throughout the American tropics and subtropics. It is abundant in Baja California Sur.

These butterflies are avid flower visitors, preferring the cultivated varieties, and "desert willow," coralvine, and large yellow composite blossoms. While these butterflies are combative, they are not as aggressive as *H. phyleus* or *C. aurantiaca*. Along with those two species *eufala* is one of the most abundant hesperiines on the peninsula.

BAJA CALIFORNIA SUR: La Paz, Hotel Guaycura grounds, 1♂ 2♀ 19-x, 1♂ 20-x, 3♂ 1♀ 21-x, 12♂ 17♀ 22-x, 1♂ 4-xi, 2♂ 1♀ 6-xi, 4♂ 7-xi, 1♂ 8-xi, 2♂ 1♀ 10-xi; southeast shore of La Paz harbor, 9♂ 8-xi, 9♂ 2♀ 10-xi, 2♂ 1♀ 5-xii; Rancho Rosarito, 1♀ 23-x; Rancho El Novillo, 1♂ 28-x; Rancho Palmarito, 7♂ 27-x, 3♂ 1♀ 31-x, 2♂ 2♀ 4-xi, 2♂ 4♀ 5-xi, 6♂ 3♂ 30-xi, 3♀ 4-xii; Arroyo Hondo, near El Triunfo, 1♂ 1♀ 24-x; Mesa Puerta Azul, 1♂ 3♀ 24-x, 2♂ 1♀ 1-xi; Arroyo San Bartolo, 2♂ 2♀ 2-xi, 1♂ 3-xi, 2♂ 2♀ 12-xi, 1♂ 14-xi; Rancho Ensenada de Palmas, 1♂ 16-xi; Bahía de Palmas, 1♂ 16-xi,

1 ♂ 20-xi; Boca de la Sierra, 1 ♀ 24-xi, 1 ♂ 28-xi; Arroyo San Bernardo, 1 ♂ 18-xi; Rancho San Bernardo, 1 ♂ 14-xi; La Ciénaga I, 1 ♂ 16-xi; San José del Cabo, 1 ♂ 22-xi, 9 ♂ 5 ♀ 23-xi, 14 ♂ 4 ♀ 25-xi; Puerto Chileno, 3 ♂ 22-xi; Cabo San Lucas, 2 ♂ 23-xi; Arroyo Candelaria, 1 ♂ 24-xi; 4 mi. south of Arroyo Candelaria, 1 ♂ 26-x, 4 ♂ 1 ♀ 24-xi.

SONORA: 5 mi. west of Riito, 1 ♂ 17-x; 10 mi. northwest of Caborca, 1 ♂ 19-x; Hermosillo, 1 ♂ 20-x; 12 mi. south of Hermosillo, 3 ♀ 20-x; 22 mi. north of Ciudad Obregon, 1 ♂ 21-x; Guaymas, 1 ♂ 21-x.

SINALOA: 16 mi. north of Mazatlán, 1 ♀ 29-x; Mazatlán, 1 ♀ 24-x, 1 ♀ 29-x, 1 ♀ 31-x.

Lerodea dysaules Godman, 1900.

This species is known only from Baja California Sur and western Mexico. It is closely related to *L. arabus* (Edwards) and is probably a subspecies of that species. There is a wide range of individual variation in the specimens before me. All males have faintly delimited spots on the under surface of the hindwing in at least spaces M_3-Cu_1 and Cu_1-Cu_2. The spotting of the forewing, however, is far more variable: the cell spot is obsolescent in one of the males, a female from Baja California, and the female from Sinaloa, and the spots in general are variously developed, from prominent to almost obsolete, particularly those in spaces M_3-Cu_1 and Cu_2-2A. The variation is without regard to the configuration of the male genitalia.

These butterflies are rather secretive skippers, little given to combativeness. They fly low, along the ground, and are attracted only to flowers that are a foot or less in height.

BAJA CALIFORNIA SUR: La Paz, Hotel Guaycura grounds, 1 ♂ 20-x, 1 ♀ 21-x, 1 ♀ 21-x; southeast shore of La Paz harbor, 1 ♂ 8-xi; Rancho Rosarito, 1 ♂ 1 ♀ 23-x.

SONORA: Hermosillo, 1 ♂ 20-x.

SINALOA: Mazatlán, 1 ♀ 28-x.

Two more specimens have been examined from the collection of the San Diego Natural History Museum.

BAJA CALIFORNIA SUR: Comondú, 1 ♂ 1 ♀ 16-xi-1952 (C. F. Harbison).

Calpodes ethlius (Stoll), 1782.

This species is abundant throughout many parts of the Neotropics, seemingly limited by the distribution of its foodplant, *Canna*. Since it has been recorded on the peninsula only from the environs of settlements where many ornamental cannas are grown year in ad year out, I am inclined to the opinion that *ethlius* is not native to Baja California, but rather was introduced there along with ornamental cannas. *C.*

ethlius is, however, a well-known migrant (see Welling, 1964), and it is possible that stray specimens have often reached Baja California on their own. But not until the advent of cultivated cannas was there opportunity for this butterfly to establish colonies there. In any event, this species is certainly not part of the natural peninsular fauna and is a recent arrival.

BAJA CALIFORNIA SUR: La Paz, Hotel Guaycura grounds, 1♂ 22-x; Bahía de Palmas, 1♂ 1♀ 16-xi, 1♂ 2♀ 20-xi.

SINALOA: Mazatlán, 2♂ 27-x, 1♂ 1♀ 29-x.

Panoquina panoquinoides errans (Skinner), 1892.

This subspecies was well characterized by MacNeill (1962: 113-114). It is known from California, most of the peninsula, and western coastal Mexico.

These butterflies are always associated with coastal grasses and are seldom found far from them. They are most active late in the afternoon, when the males will take positions on grass stems and engage one another in mock combat or will hover around females. The females generally fly deep in the grass and are not so combative as the males. These skippers seldom visit flowers, but flowers were not abundant on the tidal flats where we observed these butterflies.

BAJA CALIFORNIA SUR: La Paz, Hotel Guaycura grounds, 1♀ 22-x; southeast shore of La Paz harbor, 21♂ 5♀ 8-xi, 14♂ 10♀ 10-xi, 10♂ 10♀ 5-xii, 2♂ 6-xii; San José del Cabo, 1♂ 22-xi, 4♂ 23-xi, 5♂ 25-xi, 1♀ 26.xi.

SINALOA: Mazatlán, 2♂ 1♀ 26-x, 2♂ 1♀ 28-x, 1♂ 29♀x, 1♂ 31-x.

An additional specimen from the collection of the San Diego Natural History Museum has been examined.

BAJA CALIFORNIA NORTE: Calmallí, 1♂ 24-vii-1953.

Panoquina ocola (Edwards), 1863.

This species is widespread in the tropics and subtropics; it reaches the Antilles, but has not been recorded from the peninsula.

SONORA: 16 mi. south of Guaymas, 1♂ 1♀ 21-x.

SINALOA: 19 mi. north of Los Mochis, 1♂ 22-x; 10 mi. southeast of Los Mochis, 1♂ 2♀ 23-x; 16 mi. north of Mazatlán, 3♂ 29-x; Mazatlán, 1♀ 26-x, 1♀ 28-x; Urías, 2 mi. south of Mazatlán, 1♂ 31-x; 17 mi. east of Concordia, 1♂ 1♀ 25-x, 1♂ 1-xi.

Panoquina pauper pauper (Mabille), 1878.

A single specimen of this rather uncommon tropical species was taken by the mainland party.

SINALOA: 11 mi. north of Mazatlán, 1♀ 28-x.

Nyctelius nyctelius nyctelius (Latreille), 1824.

This species is widespread throughout western Mexico, Central and South America, and the Antilles. It is not known from the peninsula.

SINALAO: 10 mi. southeast of Los Mochis, 1 ♀ 23-x; Urías, 2 mi. south of Mazatlán, 1 ♂ 31-x; 17 mi. east of Concordia, 1 ♀ 1-xi.

Thespeius dalman (Latreille), 1824.

This species has a wide range in the continental Neotropics.

SINALOA: 17 mi. east of Concordia, 1 ♂ 1-xi.

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PALEONTOLOGY AND GEOLOGY OF THE BADWATER CREEK AREA, CENTRAL WYOMING

Part 5. The cylindrodont rodents

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Introduction

In this, the fifth in a series of papers dealing with vertebrates from Badwater Creek, Wyoming, four species of cylindriodont rodents are described, one as a new species of *Pseudocylindrodon.* All specimens are from the Hendry Ranch Member of the Tepee Trail Formation (Tourtelot, 1957) and are of late Eocene or Uintan age. There are approximately one hundred and fifty isolated cylindrodont teeth in the Badwater collections at Carnegie Museum and at the University of Colorado Museum. The large majority of these specimens are from a single locality and appear to represent a single species, but because of the lack of associated dentition, it is possible that one or two specimens that represent different populations have been erroneously grouped together. Such an error, if it exists at all, is probably minor, however, as most of the specimens appear to fall quite readily into four discrete categories.

Wood (1949) was the first to describe rodents from the late Eocene deposits along Badwater Creek, but he did not mention the presence of cylindrodonts in the fauna. However, he described and figured (1949, p. 559, fig. 11) an upper incisor which he referred to as cricetid indet. This incisor (Amherst College Museum 10004) is probably that of a cylindrodont rather than a cricetid and it appears to be referable to the new species of *Pseudocylindrondon* described below. The upper incisor of *Pseudocylindrodon medius* and of *P. neglectus* is oval in

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cross-section with a rounded anterior face and has the enamel limited to the anterior of the tooth. This is the condition described for the Amherst specimen referred to as a cricetid by Wood.

Abbreviations used in this paper are: CM, Carnegie Museum; UCM, University of Colorado Museum; a-p, anteroposterior; tr, transverse width, the first measurement given is the width of the upper teeth or the anterior width of the lower teeth, the second measurement is the posterior width of the lower teeth; N, number; O.R., observed range; M, mean; s, standard deviation; V, coefficient of variation.

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Since 1962, when we began our work along Badwater Creek, we have received all manner of assistance from Mr. and Mrs. James Hendry and their son, Rob, owners of the Clear Creek Cattle Co., on whose property most of our quarries are located. Their help and their friendship were decisive factors in making this project a success and I wish to offer our deepest thanks and appreciation for all they have done.

SYSTEMATIC REVIEW

Order Rodentia

Family Cylindrodontidae

Genus *Pseudocylindrodon* Burke, 1935

Pseudocylindrodon tobeyi[1], new species

Figures 1–24

TYPE: CM 21349, LM 1 or 2.

HYPODIGM: dP^4, CM 21301; P^4, CM 14633, 15294, 21302, 21303, 21304; M^{1-2}, CM 14636, 14637, 15295, 15298, 15302, 15304, 15309, 15312, 15313, 16076, 16764, 21305-21321; M^3, CM 15293, 15296, 15297, 15306, 15310, 21322-21332; dP_4, CM 21341; P_4, CM 15355, 16001, 16074, 16763, 21340, 21341; M_{1-2}, CM 14634, 14635, 14638, 15299, 15300, 15303, 15311, 16765, 16835, 21342-21356, 21358, 21359, 21370; M_3, CM 14632, 15305, 16017, 21357, 21360-21365.

HORIZON AND LOCALITIES: Late Eocene, Wood and Rodent localities (Black and Dawson, 1966).

DIAGNOSIS: Larger than *Pseudocylindrodon medius* and *P. neglectus*; cheek teeth not as high crowned as in *P. medius* and *P. neglectus*; M^{1-2} not as wide in

relation to length as in other species of *Pseudocylindrodon*; M^3 only partially reduced; hypoconid on P_4-M_3 not as enlarged and not pulled anteriorly as strongly as in *P. medius* and *P. neglectus*; M_3 not greatly reduced.

DESCRIPTION: The deciduous P^4 is more triangular in occlusal outline than P^4 because of the enlarged buccal half of the anterior cingulum. The cusps are quite prominent on dP^4 with the lophs poorly developed. The protoconule and metaconule are large and there is a small but distinct hypocone present. The permanent fourth premolar is as large as M^1 and M^2 and is similar in structure. P^4 differs from the molars primarily in having a much shorter anterior cingulum which never passes internally more than halfway along the anterior face of the tooth. The posterior cingulum is also shorter than it is on M^1 and M^2. No hypocone can be distinguished. On all the P^4s in the sample the metaconules are large and the metaloph is incomplete, failing to reach the internal face of the protocone. In one specimen, CM 21303, there is a short, thin crest from the metaconule to the posterior cingulum. Mesostyles are prominent on all P^4s.

It is impossible to separate the first from the second upper molars when dealing with isolated teeth and the same is true for the lower first and second molars. The descriptions given here, therefore, apply to both. As in Oligocene cylindrodonts there is considerable variation in occlusal outline of M^1-M^2 which is dependent upon the stage of wear. Generally, M^1-M^2 are somewhat wider than long but the impression is of a rather square occlusal outline. The internal border of the teeth is broad although there is no distinct hypocone. The union of the posterior cingulum with the protocone, however, is broad and the postero-internal corner of the tooth is consequently squared off. The anterior cingulum does not pass internally to the protocone, but covers only about two-thirds of the anterior face of the tooth. The mesostyles are usually large although in two specimens they are absent. In no instance is the buccal end of the central valley closed by the mesostyle or posterior slope of the paracone. There is considerable variation in the size of the metaconule which is occasionally almost undistinguishable within the metaloph, but more normally is quite large. The metaloph is either constricted at the protocone, fusing into the internal face well below the top of the cusp, or occasionally it is incomplete. In some specimens there is a short crest from the metaconule to the posterior cingulum (fig. 5) but more often the posterior valley is not bridged

[1] Named for Mrs. David Ruhala, formerly Miss Tobey Hall, who was a cheerful, able, and dedicated assistant with the Carnegie Museum field parties for three summers while we worked the Badwater area.

by such a crest. The protoloph and metaloph diverge only slightly as they pass from the protocone to the buccal margin of the tooth.



Figs. 1-21. *Pseudocylindrodon tobeyi*, isolated teeth, all approximately x7. 1. RdP^4, CM 21301. 2. RP^4, CM 21303. 3. LP^4, CM 21302. 4. $RM^{1 \text{ or } 2}$, CM 15304. 5. $LM^{1 \text{ or } 2}$, CM 15312. 6. $LM^{1 \text{ or } 2}$, CM 21321. 7. $RM^{1 \text{ or } 2}$, CM 15302. 8. RM^3, CM 21322. 9. RM^3, CM 15310. 10. LM^3, CM 21323. 11. RdP_4, CM 21341. 12. LP_4, CM 21340. 13. LP^4, CM 15355. 14. $LM_{1 \text{ or } 2}$, CM 21349, Type. 15. $RM_{1 \text{ or } 2}$, CM 14634. 16. $RM_{1 \text{ or } 2}$, CM 16835. 17 $RM_{1 \text{ or } 2}$, CM 21356. 18. $LM_{1 \text{ or } 2}$, CM 21343, 19. RM_3, CM 15299. 20. LM_3, CM 21345. 21. LM_3, CM 21367.

The third upper molars are roughly square in occlusal outline and are considerably smaller than M^1 and M^2. The protoloph and metaloph pass more or less directly across the tooth, not diverging as much as they do in the Oligocene species. A metaconule is still distinct on a few M^3s (fig. 10) but more commonly it is absent. In several specimens there is a loph from the metaloph or metaconule running posteriorly to the posterior cingulum. One or two specimens are not at all reduced, resembling M^1 and M^2 to a remarkable degree (fig. 8). There is no posterior interdental wear facet on these teeth, however, indicating they are certainly third molars.

The deciduous lower fourth premolar is quite long and narrow. The trigonid basin is wide and closed by the anterior cingulum and by a heavy posterior protoconid arm. The hypoconid is not enlarged or pulled forward as in the permanent P_4, hence the buccal valley is wide. The hypolophid is strong and there is a wide valley between the hypolophid and posterolophid.

There is considerable variation in the structure of P_4 among the specimens here assigned to *P. tobeyi* but the sample size is small and there is nothing in the sample of molars that would suggest that more than a single species is present. The amount of variation is displayed in two specimens, both taken from one quarry (figs. 12 and 13). P_4 is generally as long as M_1 and M_2 but not as wide. The protoconid and metaconid are appressed, with only a small trigonid basin intervening. There is no trace of an anterior cingulum, so that the trigonid basin opens onto the anterior face of P_4. The hypoconid is swollen and pulled anteriorly, resulting in a postero-internal direction for the buccal valley. The posterolophid is quite strong on all specimens and joins the entoconid just below the apex of that cusp, with the posterior valley thus closed off internally. The hypolophid is completely absent in one specimen (fig. 12), while it is a strong, complete crest uniting with the posterior end of the ectolophid in another (fig. 13). There are no stages of partial hypolophid development in the sample. When the hypolophid is present the posterior valley becomes isolated as a shallow basin after slight wear. The central, or talonid, basin opens internally as the entoconid and metaconid are separated by a deep cleft.

The first and second lower molars are identical as far as can be determined from a collection of isolated teeth. They are also quite uniform, showing little morphologic variation within the sample. M_1-M_2 are rectangular in occlusal outline, with the anterior half of the teeth some-

what narrower than the posterior. The trigonid basin is of moderate size in an unworn M_1 or M_2 and it is closed both anteriorly and posteriorly. The hypolophid is always well-developed as is the posterolophid. The central valley is generally open internally with no metastylid present, while the posterior valley is closed internally after moderate wear. The hypoconid is swollen and pulled forward as in the Oligocene species.

M_3 resembles M_1 and M_2 in most details but differs from them in being more variable in size. Also, in some specimens of M_3, the central valley is closed lingually and the posterior half of the tooth is somewhat reduced. This is effected through shortening of the hypolophid and posterolophid. One specimen, CM 21367, (fig. 21) is greatly reduced and approaches the condition seen in an unworn M_3 of *Cylindrodon*. However, this tooth is much lower crowned than any M_3 known of *Cylindrodon*.

DISCUSSION: In view of its age, *Pseudocylindrodon tobeyi* is amazingly similar to both *P. medius* and *P. neglectus* of the early Oligocene of Montana. There are a number of minor differences in dental morphology between the three, but *P. tobeyi* certainly bears out Burke's conviction (1935, p. 12) that "the ancestor of *Cylindrodon* in the Upper Eocene had progressed beyond the stage represented in *Pareumys*(?) *troxelli m.*" and confirms his belief that *Pareumys* could not have been ancestral to *Cylindrodon* or *Pseudocylindrodon*. By Uintan time there was at least one lineage whose cheek teeth were considerably higher crowned than in any species of *Pareumys* and this lineage could have been ancestral to *Cylindrodon* of the early Oligocene.

Pseudocylindrodon tobeyi differs from *Pareumys* not only in having considerably higher crowned cheek teeth but in a number of other features as well. The metaloph in *Pareumys* is incomplete (Wilson, 1940), whereas in *Pseudocylindrodon tobeyi* it is usually complete. The metalophids on the lower molars are always complete and close the trigonid basin, while in *Pareumys*, the metalophids are progressively shortened from M_1 to M_3. The hypoconids of *Pseudocylindrodon* are swollen and pulled anteriorly, while in *Pareumys* they are more as in *Mysops* or various ischyromyids.

Differences between *Pseudocylindrodon tobeyi* and the Oligocene species of *Pseudocylindrodon* are less striking and are usually ones of degree of development of structures rather than differing modes of development. There is less unilateral hypsodonty of P^4-M^3 in *P. tobeyi*

than in *P. medius* and *P. neglectus*, and the Badwater species is somewhat lower crowned. *P. tobeyi* is larger than the Oligocene species, and it is also larger than *Cylindrodon*. The valleys of the lower cheek teeth of *P. tobeyi* are not closed lingually as completely as they are in *P. medius* and *P. neglectus*. The hypoconid does not swing anteriorly as far nor is it as swollen in *P. tobeyi* as it is in *P. medius* and *P. neglectus*. Finally, the M3/3s of *P. tobeyi* are not as greatly reduced as those of the Oligocene species of *Pseudocylindrodon*.

Through a slight reduction in size and a further emphasis on increase in crown height, *P. tobeyi* could have given rise to *Cylindrodon*, and with less increase in crown height it could have given rise to *Pseudocylindrodon medius*. If the Badwater species was not directly ancestral to the Oligocene cylindrodonts, it was certainly much closer to the *Mysops-Cylindrodon* lineage than was any species of *Pareumys*.

Wilson (1940, p. 102, pl. 1, fig. 8) described and illustrated a single tooth from the Eocene Sespe deposits which he referred to as *Pareumys*(?) sp. This specimen was stated to differ from *Pareumys* in greater height of crown and completely enclosed posterior basin, and Wilson suggested the specimen might have affinities to the Oligocene genera *Pseudocylindrodon* and *Cylindrodon*. In addition to the characters mentioned by Wilson, the hypoconid on this specimen is more swollen and is pulled further anteriorly than it is in the other California specimens of *Pareumys* described in the same paper. This tooth resembles the

TABLE 1

MEASUREMENTS IN MILLIMETERS, *P. tobeyi*, NEW SPECIES

	N	M	s	V	O.R.
P^4 a-p	4	1.94			
tr	4	2.19			
$M^{1 \text{ or } 2}$ a-p	27	1.92	.09	4.69	1.75-2.10
tr	27	2.11	.14	6.64	1.80-2.40
M^3 a-p	14	1.78	.10	5.62	1.50-1.90
tr	14	1.74	.12	6.90	1.50-2.00
P_4 a-p	6	1.94			
tr metalophid	6	1.23			
hypolophid	6	1.85			
$M_{1 \text{ or } 2}$ a-p	22	1.96	.11	5.61	1.80-2.20
tr metalophid	22	1.69	.14	8.28	1.45-1.95
hypolophid	22	1.95	.10	5.13	1.75-2.10
M_3 a-p	7	2.06			
tr metalophid	7	1.81			
hypolophid	7	1.74			

lower molars of *Pseudocylindrodon tobeyi* to a great extent and it may represent a species of *Pseudocylindrodon* in the California late Eocene which is at the same level of development as the population at Badwater.

?*Pseudocylindrodon* sp.
Figures 25–30

MATERIAL: RP^4, CM 15568; LM^3, CM 16896; M_{1-2}, CM 14813, 15314, 15578, 17504, UCM 24773, 24774; M_3, CM 15315, UCM 24765, 24828.

HORIZON AND LOCALITIES: Late Eocene, localities 5, 5A, 6, and 7 (Black and Dawson, 1966).

DESCRIPTION: The P^4 is unilaterally hypsodont but not as high crowned as the upper fourth premolars of *Pseudocylindrodon tobeyi*. The protoloph and metaloph are complete with no distinct conules present. These lophs are rather low, joining the protocone considerably below the top of that cusp. There is no hypocone or mesostyle. The anterior cingulum is long, while the posterior cingulum is short and does not reach the buccal margin of the tooth.

The tooth here considered to be an M^3, CM 16896, has an unusual pattern unknown in any other cylindrodonts. Both the protoloph and the metaloph fail to reach the protocone. Instead they are both joined to a short ridge that passes between them from the protocone. The protocone itself is hardly distinguishable as a cusp, rather the entire lingual ridge of the tooth is thickened. The anterior and posterior cingula are of equal length and neither reaches the buccal border of the tooth.

M_1 and M_2 are rectangular in occlusal outline. They are somewhat lower crowned than the molars of *P. tobeyi*, but are higher crowned than any *Pareumys* molars. The posterior protoconid arm is not fused to the posterior slope of the metaconid and in some specimens it is directed posteriorly so that the trigonid basin is open to the rear (figs. 27 and 28). The hypolophid is strong in all specimens and the hypoconulid is distinct. The central and posterior valleys are usually open lingually, but they are partially closed in CM 15578. The hypoconids are not greatly swollen and there is only slight indication of the antero-buccal torsion of the hypocone seen in other species of *Pseudocylindrodon*.

On M_3 the posterior protoconid arm is very short, with the trigonid basin open posteriorly. The central valley is open, but the posterior valley is closed. The posterior half of the tooth is only slightly reduced through shortening of the posterior cingulum.

DISCUSSION: It is possible that these nine specimens do not all represent the same species. The seven lower teeth from four different localities all seem reasonably alike morphologically. The association of the P^4 and M^3 with the others is very questionable. Both these teeth, however, appear to be cylindrodont in morphology, and are of the proper size to be associated with the lower teeth. Nevertheless, no cylindrodont known possesses some of the features seen in the P^4 and M^3, while the lower teeth are similar to lower molars known for other species of *Pseudocylindrodon and Pareumys.*

The lower teeth appear to be intermediate between *Pareumys* and *Pseudocylindrodon.* They differ from *Pareumys* and resemble *Pseudocylindrodon* in: (1) being slightly higher crowned; (2) having some swelling and anterior torsion of the hypocone. They differ from *Pseudocylindrodon* and resemble *Pareumys* in having: (1) open central and posterior valleys; (2) short posterior protoconid arm with open trigonid basin.

The material is too scrappy and distinctions still too hazy to warrant description of a new taxon. This taxon, if indeed these specimens represent a single taxon, is more primitive than *Pseudocylindrodon tobeyi* and more advanced than the Badwater or any other species of *Pareumys.*

TABLE 2

MEASUREMENT IN MILLIMETERS, ?*Pseudocylindrodon* SP.

		a-p	tr	tr
CM 15568	RP^4	1.95	2.70	
CM 18896	LM^3	1.90	2.15	
CM 15314	$LM_{1 \text{ or } 2}$	2.20	2.00	2.30
CM 15578	$LM_{1 \text{ or } 2}$	2.40	2.30	2.60
CM 14813	$RM_{1 \text{ or } 2}$	2.25	2.10	2.35
CM 17504	$RM_{1 \text{ or } 2}$	2.10	1.70	1.90
UCM 24773	$LM_{1 \text{ or } 2}$	2.40	2.20	2.45
CM 15315	LM_3	2.35	2.10	
UCM 24828	LM_3	2.20	2.10	

Genus *Pareumys* Peterson, 1919

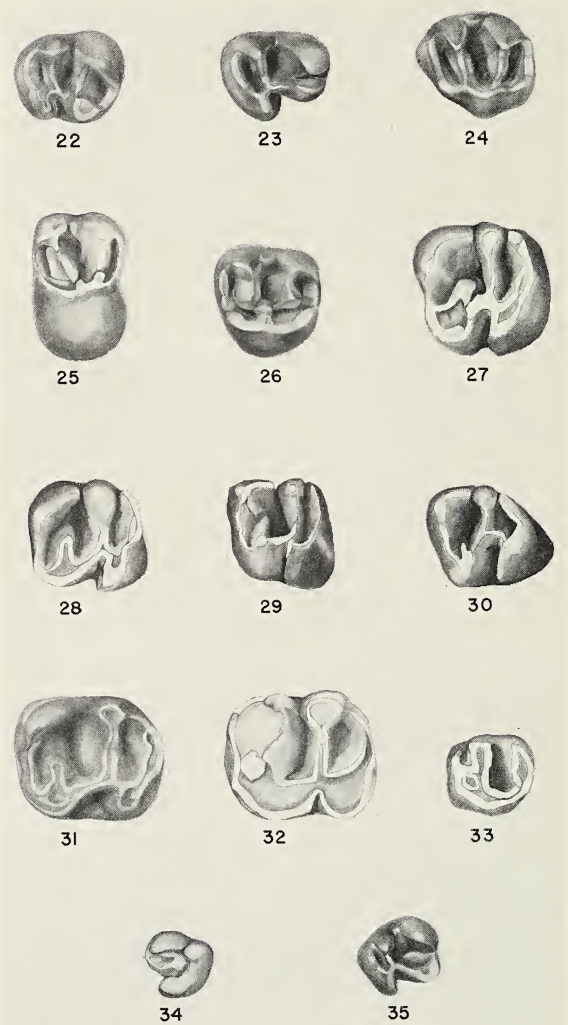
Pareumys sp.

Figures 31–32

MATERIAL: CM 15989 and CM 15990, both left M_1 or M_2.

HORIZON AND LOCALITY: Late Eocene, locality 6 (Black and Dawson, 1966).

DESCRIPTION: Both molars are low crowned and have low lophids, much lower than those of *Pseudocylindrodon tobeyi.* The hypolophids



Figs. 22-35. Badwater cylindrodonts, all approximately x7. 22-24, *Pseudocylindrodon tobeyi*. 22. RM_3, CM 15308. 23. RP_4, CM 21339. 24. $LM^{1 \text{ or } 2}$, CM 15301. 25-30, ?*Pseudocylindrodon* sp. 25. RP^4, CM 15568. 26. LM^3, CM 16896. 27. $LM_{1 \text{ or } 2}$, CM 15578. 28. $LM_{1 \text{ or } 2}$, UCM 24773. 29. $LM_{1 \text{ or } 2}$, CM 15314. 30. LM_3, CM 15315. 31-32, *Pareumys* sp. 31. $LM_{1 \text{ or } 2}$, CM 15990. 32. $LM_{1 \text{ or } 2}$, CM 15989. 33-34, ?Cylindrodont sp. 33. RP^4, CM 21371. 34. LP_4, CM 21369. 35. RM_3, CM 21366.

are somewhat lower than those of *Pareumys milleri* or *P. grangeri*. The two Badwater teeth are appreciably longer than wide, another *Pareumys* character in contrast to *Pseudocylindrodon*. The hypoconids of *Pareumys* sp. are not swollen nor do they show any anterior torsion as they do in the higher-crowned cylindrodonts. The posterolophids are low and the hypoconulids indistinct. The central and posterior valleys are broad and shallow. There is no metastylid. On CM 15990 the posterior protoconid arm passes into the metaconid slope isolating the trigonid basin from the talonid. These two teeth are slightly larger than either the first or second molars of *Pareumys milleri* or *P. grangeri* and the cusps and crests of the Badwater specimens are somewhat lower than in the Uinta species. In all other respects, however, they are quite close to CM 2938, the type of *P. milleri*.

There is not sufficient material available from this Badwater population of *Pareumys* to allow specific determination. It is impossible to tell whether this population is consistently larger than *P. milleri* or merely a slightly larger variant of that species.

TABLE 3

MEASUREMENTS IN MILLIMETERS

		a-p	tr	tr
CM 15989	$LM_{1 \text{ or } 2}$	2.55	2.35	2.40
CM 15990	$LM_{1 \text{ or } 2}$	2.55	2.30	2.30

?Cylindrodontid sp. small species
Figures 33–35

MATERIAL: RP^4, CM 21371; LP_4, CM 21369; RM_3, CM 21366.

HORIZON AND LOCALITY: Late Eocene, Wood locality (Black and Dawson, 1966).

DESCRIPTION: All teeth are extremely small, much smaller than those known for any other cylindrodontid. On P^4 the metaloph is complete but there is a second crest from the metaconule to the posterior cingulum (fig. 33). The tooth is unilaterally hypsodont. The anterior cingulum is quite short, a character commonly found on P^4s of other cylindrodonts. There is no mesostyle and there is no distinct hypocone. On the lower premolar there is almost no separation between the protoconid and metaconid. There is no hypolophid. The hypoconid is swollen and pulled slightly forward. The ectolophid does not reach the hypoconid, leaving the central basin of the tooth open into the buccal valley. The M_3 has no posterior protoconid arm, so there is no trigonid basin. There is just an open slope from the anterior margin of

the tooth into the talonid basin. There is a strong hypolophid (fig. 35) on M_3 and the hypoconid is enlarged and has a slight anterior torsion.

These three teeth are tentatively referred to the Cylindrodontidae because they display several characters common to that family and not found in other late Eocene rodent families: (1) unilateral hypsodonty of P^4; (2) enlargement of hypoconid and its anterior direction on P_4 and M_3; and (3) strong hypolophid on M_3. There is, of course, no certainty that these three should be associated. However, because of their occurrence together at one locality, their uniform small size, and their similarity to other cylindrodonts, the association seems possible.

The incomplete ectolophid on P_4 and the complete absence of a posterior protoconid arm on M_3 are unique features unknown in other cylindrodonts, although some third lower molars of *Pareumys* have the posterior protoconid arm greatly reduced. The three teeth are relatively higher crowned than those of *Pareumys,* however, and the hypoconid development differs from that in *Pareumys.*

It is of interest that the three specimens are all from a single locality. This small species has not been found at any of the other localities where large samples also have been collected using washing techniques. It is hoped that future work will give us more information about this unique, tiny cylindrodont.

TABLE 4

MEASUREMENTS IN MILLIMETERS

	a-p	tr	tr
CM 21371 RP^4	1.25	1.50	
CM 21369 LP_4	1.10	.75	1.15
CM 21366 RM_3	1.40	1.20	1.25

Distribution of Badwater Cylindrodonts

The sample of cylindrodont teeth studied in this report is not large. Nevertheless, a pattern of distribution of species between localities in the Hendry Ranch Member emerges that is probably real. The samples of teeth from localities 5, 5A, 6, and Wood were recovered from concentrate resulting from the washing of at least four tons of matrix from each locality. The concentrate from each locality appears to be equally rich both in the number of total mammalian specimens and in the number of mammalian taxa represented. There is still a small amount of unsorted concentrate from 5A and much larger amounts from 5, 6, and Wood. However, it is unlikely that sorting of this concentrate will

change the distribution pattern of cylindrodont species at these localities, even though it will certainly alter the number of individuals and perhaps of the percentage of cylindrodonts in relation to the total fauna at each locality. The cylindrodont samples from localities 7 and Rodent were obtained through surface prospecting, and consequently may not reflect a true picture of species diversity at these two localities. I doubt this, however, as the general pattern for all localities seems to suggest an association of localities 5, 5A, 6, and 7 on the one hand, and Wood and Rodent on the other. Locality 7 is thus grouped with three localities from which large samples of matrix have been processed, and the Rodent locality is also grouped with a locality from which a large sample has been taken.

Two cylindrodont species found at Badwater are known from such small samples that little faith could be placed on any generalizations based on them. *Pareumys* sp., the most primitive of the Badwater species, is known from only two specimens recovered a locality 6. The very small cylindrodont is known from only three specimens from the Wood locality. This species is certainly more advanced than the *Pareumys* species.

The really striking distribution pattern is provided by *Pseudocylindrodon tobeyi*, which is known to occur only at the Wood and Rodent localities, with only a half-dozen of the nearly one hundred teeth coming from the latter locality. With the concentrate resulting from the processing of at least twelve tons of matrix sorted, no specimens of *P. tobeyi* are known from localities 5, 5A, 6 or 7. That *P. tobeyi* is totally absent, or at the very least, exceedingly rare at these localities is, I believe, certain. At localities 5, 5A, 6, and 7, on the other hand, we find ?*Pseudocylindrodon* sp. a somewhat more primitive species than *P. tobeyi*. ?*Pseudocylindrodon* sp. is not common at these localities, however, as *P. tobeyi* is at the Wood locality.

Whether this difference in faunal composition, which is seen in the cylindrodont rodents between these six localities, is due to age, ecology, or some other unforeseen sampling factor is unanswerable at present. It is interesting to note that *Parectypodus lovei* (Sloan, 1966) is known from localities 5, 5A, and 6 from twenty specimens, but that only one specimen is known from the Wood locality. (Sloan, in his publication, did not mention the five specimens from 6 and the one from Wood. These have been recovered from the concentrate since 1966). As more of the Badwater fauna is described, a clearer understanding of faunal

differences should result. At present only eleven of the species listed by Black and Dawson (1966) have been reviewed, and additional material is already known for five of the seven species discussed by Robinson (1968). This additional material in no way modifies the systematics Robinson presented but does alter the locality distribution for some taxa.

On the basis of the cylindrodonts alone there is a slight suggestion that the Wood and Rodent locality faunas are either somewhat younger than those from 5, 5A, 6, and 7 or that there was an ecological difference reflected in the depositional environment.

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VOLUME 41 ANNALS OF CARNEGIE MUSEUM ARTICLE 7

PALEONTOLOGY AND GEOLOGY OF THE BADWATER CREEK AREA, CENTRAL WYOMING

Part 6. The leporid *Mytonolagus* (Mammalia, Lagomorpha)

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INTRODUCTION

One of the best represented small mammals in upper Eocene localities along Badwater Creek is *Mytonolagus*. Specimens of this leporid have been found there at all localities of this level, not only isolated teeth but also maxillae, partial jaws, and a few postcranial parts.

The genus *Mytonolagus*, the only described North American late Eocene leporid, was first reported from Uintan (Myton) and Duchesnean (Randlett) aged deposits in the Uinta Basin (Burke, 1934), where the species *M. petersoni* occurs. Later, Wood (1949) reported the genus from along Badwater Creek and named the new species *M. wyomingensis* on the basis of his Wyoming material. Thirteen isolated teeth from one locality (Wood Locality of Black and Dawson, 1966: fig. 1; this and other localities shown there) constituted Wood's sample. A later collection from a different upper Eocene locality along Badwater Creek (Gazin, 1956:8), probably Locality 5, 6, or 7, yielded a maxilla with P^3-M^2 that was referred to *M. wyomingensis*. Other reports of *Mytonolagus* since Burke's original description are Russell's (1965:8-9) reference of material from Swift Current Creek, Saskatchewan, to the Uinta Basin species, *M. petersoni*, and Black's mention (1967:62) of the genus in the Shoddy Springs (Montana) local fauna.

New material from Wood Locality adds to the record of *M. wyomingensis* from its type locality. Even more abundant, however, are specimens of *Mytonolagus* from Localities 5 and 6, located to the west of Wood Locality. These specimens differ from those from the type

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locality in a number of characters, most of which indicate a more primitive level of development than in *M. wyomingensis.* Locality 7 also has yielded remains of *Mytonolagus,* although less abundant, in a level of development comparable to that at localities 5 and 6. Specimens from localities 5, 6, and 7 are all referred to here as *Mytonolagus* near *M. petersoni.* Finally, Rodent Locality has produced specimens referable to *M. wyomingensis,* although these show a few differences, possibly advances, from Wood Locality specimens.

The following abbreviations have been used: ACM, Amherst College Museum; CM, Carnegie Museum; NMC, National Museum of Canada; ROM, Royal Ontario Museum; UCM, University of Colorado Museum; USNM, United States National Museum.

ACKNOWLEDGEMENTS: This study is part of a project supported by National Science Foundation grants GB-1266, GB-4089, and GB-7901. Comparative studies of Asian lagomorphs were made possible by a grant from the Marsh Fund, National Academy of Sciences, and a Smithsonian Foreign Currency Grant. Some of the field work costs and all the publication costs have been defrayed by a grant from the Gulf Oil Corporation to the Section of Vertebrate Fossils. Illustrations were prepared by A. Lee Ambrose.

SYSTEMATICS

Mytonolagus wyomingensis

Figures 1-12, Table 1

LOCALITIES: Wood (type) Locality (63 teeth in CM; 13 teeth in ACM) and Rodent Locality (25 teeth in CM).

EMENDED DIAGNOSIS: Species of *Mytonolagus* with buccal root on P^{3-4} showing some sign of separation into two parts. Hypostria on P^3-M^2 more persistent than in M. *petersoni.* On M^{1-3} limit of enamel deposition reached buccally before tooth is worn out; buccal pattern eliminated at relatively earlier wear stage than in *M. petersoni.* Trigonid of P_3 narrower transversely than talonid, has anterolingual groove in early wear; following wear trigonid and talonid united medially between buccal and lingual folds, and finally lingual fold worn away. On P_4-M_3 posterolophids present in early wear; lingual groove between trigonid and talonid persists nearly as far as buccal groove.

DESCRIPTION: Only isolated teeth are known, but they provide a more complete sample and show a greater range of wear stages than in the sample available to Wood.

No unworn or little-worn specimens of P^2 are represented. The worn pattern (fig. 1) shows three lobes transversely oriented. The central lobe is largest and protrudes anteriorly. The groove between central

TABLE 1

MEASUREMENTS IN MILLIMETERS OF *Mytonolagus wyomingensis*

	Number	Observed Range	Mean
P^2 a-p	2	1.15-1.22	1.19
width		1.49	1.49
P^3 a-p	4	1.70-1.90	1.80
width		2.44-3.46	2.88
P^4 a-p	3	1.83-2.03	1.95
width		2.41-3.05	2.69
M^1 a-p	1	1.83	1.83
width		2.85	2.85
M^2 a-p	2	1.36-1.70	1.53
width		2.17-2.37	2.27
M^3 a-p	3	0.81-0.95	0.86
width		1.36-1.73	1.56
P_3 a-p	4	1.76-2.03	1.88
width trigonid		1.22-1.42	1.35
width talonid		1.63-1.83	1.72
M_3[1] a-p	1	1.42	1.42
width trigonid		1.46	1.46
width talonid		1.19	1.19

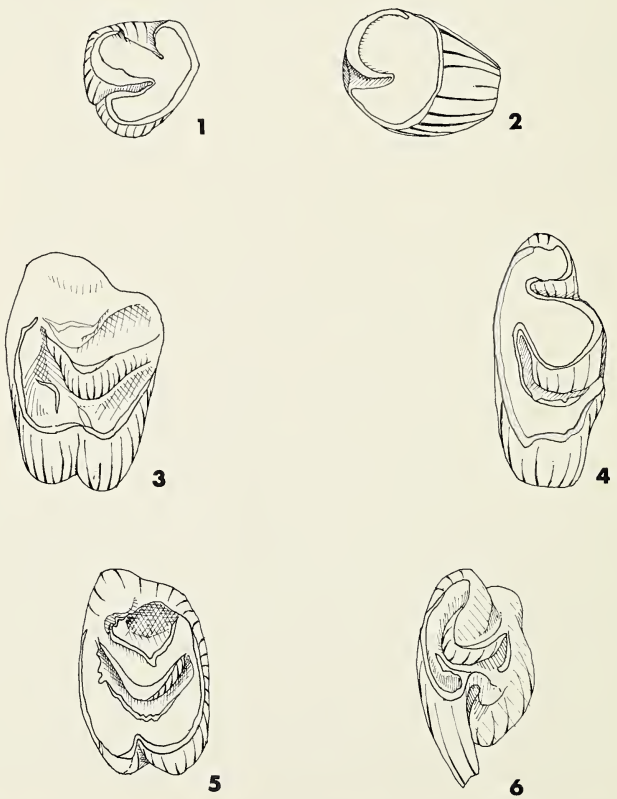
[1]Rodent Locality; all others from Wood Locality.

lobe and the small buccal lobe persists less far than that between central and lingual lobes. Following greater wear (fig. 2) this buccal lobe loses its separation from the central lobe, with a two-lobed tooth resulting. The single root bends posteriorly at its distal end.

There is considerable variation among specimens of P^3 from Wood Locality, apparently both age and individual, in development of the anterior loph. In all relatively little-worn teeth, however, the anterior loph does not reach the buccal wall of the tooth, and two valleys, one buccal and one lingual to the central lobe, thus open onto the anterior face of the tooth (fig. 3). The central lobe does not contact the anterior loph. Wood's type specimen of *M. wyomingensis*, ACM 10022, is a tooth, broken anterobuccally, that he described as P^3. On this tooth it appears that the central lobe contacts the anterior loph. This condition is not duplicated in unbroken specimens of P^3 from the type locality, but can be found on P^4. It seems likely that Wood's type specimen is actually P^4. Following wear, P^3 becomes widened transversely (fig. 4), and in the most-worn known specimens has all pattern eliminated except the crescentic valley lingual to the central lobe. There is one buccal root, usually grooved medially and variable in showing one or two pulp cavities at its distal end.

Only two specimens of P^3 are known from Rodent Locality, but these show some advance over those from the type locality in having a central lobe that bends more sharply anterobuccad, and two distinct pulp cavities in the buccal root.

On P^4 the buccal root is grooved medially, and has two pulp cavities. The pattern in a moderately worn specimen (fig. 5) shows a shallow hypostria, central lobe that contacts the well-developed anteroloph, and posterior (Wood's metacone), or posterior and anterior (Wood's paracone), buccal cuspules. As with P^3, the one known P^4 from Rodent Locality is advanced beyond those from the type locality in the more pronounced anterobuccal swing of the central lobe and in the greater separation of the buccal root into two parts.



Figs. 1-6. *Mytonolagus wyomingensis*, occlusal views of teeth, x 10. fig. 1: CM 21613, left P^2. fig. 2: CM 15233, left P^2. fig. 3: CM 15219, right P^3. fig. 4: CM 21610, right P^3. fig. 5: CM 21614, right P^4. fig. 6: CM 15439, left M^1.

On little-worn M^1 (fig. 6) the central lobe has a more pronounced posterobuccal protrusion than on M^2 (fig. 7). Following wear, the pattern becomes reduced to crescent and hypostria, and finally the buccal part of the hypostria forms an isolated lake. Deposition of the enamel is such that in well-worn specimens the tooth is past the enamel limit on the buccal side.

The three known specimens of M^3 from Wood Locality show that the tooth is reduced and compressed anteroposteriorly. The least-worn specimens (fig. 8) show the tooth to be composed primarily of the trigon. A deep buccal fold is present within the trigon and a very small posterior protrusion represents the talon. With wear, all pattern except a lingual groove, comparable to the hypostria on M^{1-2}, is present between trigon and talon. In the most worn stage known (fig. 9), the tooth is a cylinder, enamel is absent posterobuccally, and the only trace of pattern is a small enamel-lined lake, the remnant of the buccal end of the hypostria.

No unworn specimens of P_3 are known, but in the least-worn specimens available, trigonid and talonid are separate columns; the trigonid has an anterolingual fold, and the talonid is wider than the trigonid (fig. 10). Following greater wear the fold is lost, the trigonid becomes relatively wider, though still narrower than the talonid, and the two columns become joined by a medial bridge, resulting in lingual and buccal folds. Finally, the lingual fold loses its connection with the lingual wall and forms an isolated lake, which is worn away following still greater wear.

Well developed posterolophids occur on P_4-M_2 in early stages of wear. The lingual groove between trigonid and talonid persists nearly as far down the tooth as does the buccal fold. None of the specimens shows a lingual bridge between the columns, although this might form in a very well-worn tooth. The talonid is slightly narrower transversely than the trigonid and both taper buccally.

The only known M_3 is from Rodent Locality. This tooth has separate trigonid and talonid, with the posterolophid indicated by a posterior expansion of the tooth and a posterobuccal groove.

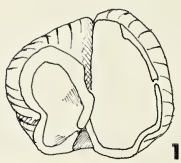
Only two specimens of deciduous teeth are known. DP^2 (fig. 11) has three transversely oriented lobes, which join one another posterobuccally. The buccal lobe is very small and the lingual lobe forms most of the posterior wall. DP^4 of *M. wyomingensis* (fig. 12) is less worn than that of *M. petersoni,* CM 11932, having the hypostria still con-

nected to the lingual side of the tooth. The anterior arm of the central lobe joins the anterior lobe bucally at this stage of wear, whereas in the more worn dP^4 of *M. petersoni,* anterior and central lobes are still independent bucally.













Figs. 7-12. *Mytonolagus wyomingensis,* occlusal views of teeth, x 10. fig. 7: CM 15221, right M^2. fig. 8: CM 16012, right M^3. fig. 9: CM 16013, left M^3. fig. 10: CM 15224, right P_3. fig 11: CM 21654, right dP^4. fig. 12: CM 21612, left dP^4.

DISCUSSION: In his description and discussion of *Mytonolagus wyomingensis,* Wood (1949:561-565) considered some of this species' characters to be more primitive and some more advanced than in *M. petersoni,* but he concluded that *M. wyomingensis* is "a form close to, and perhaps even more primitive than, the Uinta *Mytonolagus petersoni.*" The characters considered primitive by Wood, which were taken from

ACM 10022, interpreted by him as P^3 but here as P^4, were position of the metacone, and the poorly developed hypocone. The now-known specimens of both P^3 and P^4 show that these teeth in *M. wyomingensis* are actually more advanced than in *M. petersoni.* On P^3 and P^4 the hypostria, separting "protocone" and "hypocone" parts of the lingual lobe, is more persistent than in *M. petersoni,* and P^4 has better developed anterior buccal cuspules (paracone and metacone of Wood). It is not clear whether Wood considered the formation of two buccal roots on the premolars as a primitive or an advanced feature of *M. wyomingensis,* but it appears to be advanced. In the most prinimtive known late Eocene lagomorph, the Asian *Lushilagus lohensis,* both P^3 and P^4 have a single buccal root (Li, 1965:30). This condition occurs also in *Mytonolagus petersoni.* The subdivision of the buccal root into two parts, which begins to occur in *M. wyomingensis,* is a stage of advance beyond *M. petersoni* and leads toward the condition of two buccal roots on P^{3-4} such as occurs in the early Oligocene leporids *Palaeolagus temnodon and Megalagus brachyodon.* In these forms on P^3 the anterior buccal root is fused to the large lingual root, and the two buccal roots of P^4 are free. Loss of buccal roots on premolars and molars that occurred in the more progressive lines of leporids during the Oligocene was accompanied by increased hyposodonty and atrophy of more buccal parts of the upper cheek teeth. In the molars also *M. wyomingensis* shows advance beyond *M. petersoni,* especially in longer persistence of the hypostria and earlier elimination of buccal parts of the molar pattern. The leporid from Badwater Localities 5, 6, and 7, described below, seems to be a good intermediate between *M. wyomingensis* and the more primitive *M. petersoni.*

Mytonolagus near *M. petersoni*

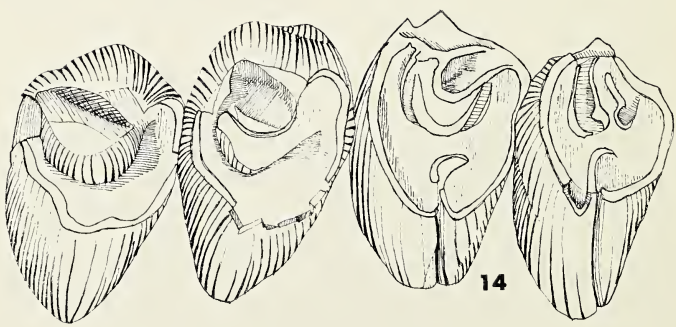
Figures 13-27, Tables 2, 3

LOCALITIES: 5 (70 teeth, 3 maxillae, 2 jaw fragments in CM), 5A (52 teeth, 1 jaw fragment in CM; 21 teeth in UCM), 6 (37 teeth, 6 maxillae, 1 jaw in CM), 7 (11 teeth in CM); 5, 6, or 7, USNM 21090, left maxilla with P^3M^2.

DESCRIPTION: This leporid is represented by more complete upper and lower jaw material than is *M. petersoni* from the Uinta Basin. The parts than can be compared show agreement between the two forms in most features. The zygoma protrudes laterally about in line with the anterior margin of P^4, which is slightly more posterior than in *Palaeolagus temnodon.* There are two mental foramina on the jaw

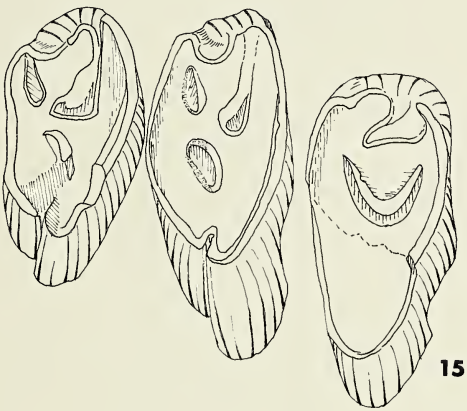
(fig. 13), the more posterior of which is in line with the talonid of P_4, as in *M. petersoni*. The more anterior foramen is relatively far forward below the diastema, in an area not preserved in known specimens of *M. petersoni*. The anterior mental foramen is more posteriorly situated on the diastema in *P. temnodon*. The anterior border of the masseteric fossa reaches to below M_3, with a knob and fairly well-developed ridge forming the anteroventral border of the fossa. On the medial surface of the jaw the swelling over the shaft of the incisor terminates posteriorly in a line below the anterior of M_2, about as in *M. petersoni*.

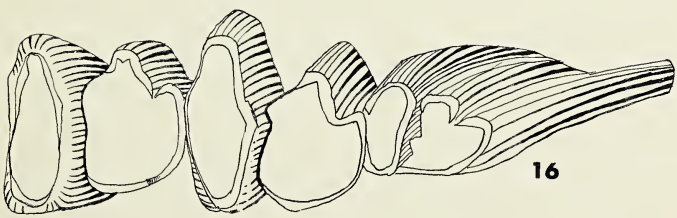




Figs. 13-14. *Mytonolagus* near *M. petersoni*. fig. 13: CM 21615, lateral view of left jaw, x 2½. fig. 14: CM 19742, occlusal view of left P^3-M^2, x 10.

Considering the proportions of the cheek teeth to one another (figs. 14, 15, 16) in both *M. petersoni* and *Mytonolagus* near *M. petersoni*, M^2 is slightly smaller than M^1, with the reduction of M^2 especially marked posterobuccally. *Palaeolagus temnodon* has a relatively more reduced M^2. In the lower jaw M_{1-2} are subequal in *M. petersoni* and *Mytonolagus* near *M. petersoni*, or M_2 may be slightly larger. Both these molars are larger than P_4. In *P. temnodon*, P_4-M_2 are more nearly equal in size.





Figs. 15-16. *Mytonolagus* near *M. petersoni*, occlusal views of teeth in jaws, x 10. fig. 15: CM 14403, right P^4-M^2. fig. 16: CM 19770, right M_{1-3}.

The groove of the upper incisor is slightly medial of center, and the medial portion protrudes farther anteriorly than the lateral.

The first upper cheek tooth, P^2 (fig. 17), consists of three lobes, transversely oriented as in *M. wyomingensis*. Even in the most worn specimen available, three lobes are still present as they are in the very worn type specimen of *M. petersoni*, and it appears that the two-lobed

shape found in worn P^2 of *M. wyomingensis* would not occur here. The roots are fused into a wider posterior and narrower anterior part or may separate into two parts at the distal end.

As in *M. petersoni* and *M. wyomingensis*, P^3 exhibits variation in transverse width of the anterior loph. The lingual groove is barely indicated, even in relatively unworn teeth, and thus is similar to that in *M. petersoni*, but less well developed than in *M. wyomingensis*. The single buccal root has one pulp cavity, as in *M. petersoni*.

The lingual hypostria is only rudimentary on P^4 (fig. 18), shallow even in relatively little-worn teeth. The central lobe remains distinct from the anterior lobe until well worn. The tooth is less well developed anterobuccally than in *M. wyomingensis*, has less buccad development of the anterior lobe, and less development of the antero-buccal cusp. The buccal root is grooved but has only a single pulp cavity.

The central lobe of M^1 and posterobuccal part of that tooth are better developed than on M^2. In relatively little worn examples of both teeth, the central lobe has a contact with the lingual shelf and a posterobuccal protrusion which is better developed and extends farther on M^1 than on M^2. The hypostria curves strongly posterobuccad at this stage of wear. After greater wear the central lobe loses its connection to the lingual shelf and the buccal tip of the hypostria forms an isolated lake. These teeth differ from those of *M. petersoni* in two principal features. First, the hypostria extends closer to the enamel limit than in *M. petersoni*. Second, the central lobe in this Badwater form shows some advance: on M^1 it is more concave buccally and its posterior connection is oriented more posterobuccally than directly posteriorly, as in *M. petersoni;* on M^2 the central lobe has a stronger posterior protrusion than in *M. petersoni*. Even in very well worn teeth, traces of pattern are preserved buccal to the central lobe. These traces do not occur in *M. wyomingensis* in comparable stages of wear. Enamel persists on the buccal side of the molars even in very well worn stages in contrast to *M. wyomingensis*, in which the buccal enamel is absent in well worn teeth.

It appears that considerable reduction has already affected M^3 (figs. 19-21), but the tooth is distinctly more robust and less reduced than in *M. wyomingensis*. When unworn, the trigon shows a strong V-shape with a rounded remnant of the central lobe in the buccal opening of the V. Posterior to this is the protrusion of the talon, developed lingually but not bucally. In the most worn specimen available there

is a hypostria, lingually between trigon and talon, and an isolated lake. The only known, very worn M^3 of *M. petersoni,* CM 11937, is somewhat larger than most specimens of this tooth of *Mytonolagus* near *M. petersoni.*











Figs. 17-21. *Mytonolagus* near *M. petersoni,* occlusal views of teeth, x 10. fig. 17: CM 18245, right P^2. fig. 18: CM 21653 left P^4. fig. 19: UCM 24748, left M^3. fig. 20: UCM 24781, left M^3. fig. 21: CM 21620, right M^3.

The lower incisor, as in *M. wyomingensis* and *M. petersoni,* is relatively narrower transversely in its ventral part than is that of *Palaeolagus temnodon.*

In the least-worn specimen of P_3 (fig. 22) a small posterolophid is still indicated by posterolingual fold, and the trigonid has a well-

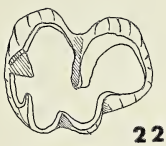
developed anterolingual notch. The presence or absence of a connection between trigonid and talonid is variable, some specimens having a connection near the lingual side, while in others, seemingly in comparable stages of wear, trigonid and talonid remain separate. The trigonid and talonid are nearly equal in width (fig. 23), as opposed to a narrower trigonid in *M. wyomingensis*. There is never a deep lingual fold as in *M. wyomingensis*. In very well worn teeth (fig. 24) the pattern consists of a buccal fold and an isolated lake lingual to the fold, a remnant of the more lingual part of the trigonid-talonid fold. The only know P_3s of *M. petersoni* are very worn, retaining only the buccal fold between trigonid and talonid.

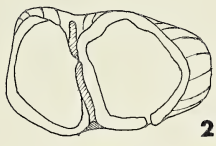
The pattern on P_4-M_2 generally resembles that in *M. wyomingensis*, with a well-developed posterolophid present in early wear. These teeth are hypsodont but M_2 shows toward its distal end a constriction of the rooted portion. The lingual groove between trigonid and talonid is more persistent relative to the buccal groove than in *M. petersoni*. Following wear the talonid extends an anterolingual process toward the trigonid, but in known specimens the columns do not join as they do in the very worn type of *M. petersoni*.

Little-worn M_3 has a two-cusped trigonid, two cusped talonid, and well-developed, cuspate, posterolophid. With wear the cusps are flattened, and trigonid and talonid join lingually. Next, trigonid and talonid join buccally also, first with an enamel-ringed lake between them that is finally worn away. In the most worn M_3 available, the posteroexternal groove between talonid and posterolophid is also worn away. The tooth is relatively larger, especially anteroposteriorly, than that of *M. wyomingensis*.

All deciduous teeth except dP^2 are represented. Little worn dP^3 (fig. 35) has a shallow hypostria and a long anterior lobe, which extends to the buccal wall anterior to the central lobe. The hypostria is removed with wear. DP^4 has a hypostria that forms an isolated lake following wear. Its crescentric valley lingual to the central lobe connects to the buccal wall in earlier stages of wear but loses the connection later. An isolated lake is buccal to the central lobe. Out of the four known dP_3s, none are unworn. The least worn shows that the tooth had three lobes anteroposteriorly and a protruding posterolophid. The two anterior lobes join first (fig. 26). In greatly worn specimens the three lobes are joined. As on dP_3, the talonid of dP_4 has a protruding postero-

lophid. Following wear the two lobes of dP_4 (fig. 27) become joined lingually by a bridge.

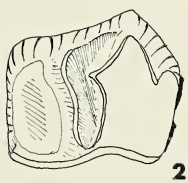












Figs. 22-27. *Mytonolagus* near *M. petersoni,* occlusal views of teeth, x 10. fig. 22: CM 15440, left P_3. fig. 23: CM 16810, left P_3. fig. 24: CM 15186, right P_3. fig. 25: CM 15175, right dP^3. fig. 26: CM 21607, left dP_3. fig. 27: CM 21652, right dP_4.

DISCUSSION: The leporid from localities 5, 6, and 7 differs from *M. petersoni* mainly in its relatively longer hypostria on the upper molars, longer lingual fold between trigonid and talonid in the lower molars, and in evidence of a more crescentic shape of the central lobe on M^{1-2}. It and *M. petersoni* differ from *M. wyomingensis* in having a more persistent buccal lobe on P^2, having on P^{3-4} a single root with little or no subdivision into two parts and less development of the hypostria, retaining into later wear stages the folds buccal to the central lobe and buccal enamel on M^{1-2}, and having less reduced M^3. The differences

between *M. petersoni* and *Mytonolagus* from localities 5, 6, and 7 suggest a more advanced level of development in the latter. These two forms seem more similar to one another than either is to *M. wyomingensis,* but differences of the Badwater form from the Uinta Basin species suggest that the former should be referred to as *Mytonolagus* near *M. petersoni.*

TABLE 2

MEASUREMENTS IN MILLIMETERS OF TEETH IN JAWS OF *Mytonolagus* NEAR *M. petersoni*

	CM 19742	CM 14403	CM 21615	CM 19770
P^3 a-p	1.97	------	------	------
width	2.58	------	------	------
P^4 a-p	2.10	1.83	------	------
width	3.05	3.63	------	------
M^1 a-p	2.17	1.83	------	------
width	------	3.36	------	------
M^2 a-p	1.97	1.76	------	------
width	------	3.02	------	------
P_4 a-p	------	------	2.17	------
width trigonid	------	------	2.10	------
width talonid	------	------	1.56	------
M_1 a-p	------	------	2.37	2.30
width trigonid	------	------	2.17	2.14
width talonid	------	------	1.66	1.86
M_2 a-p	------	------	2.27	2.30
width trigonid	------	------	2.37	------
width talonid	------	------	1.70	1.83
M_3 a-p	------	------	------	1.63
width trigonid	------	------	------	1.36
width talonid	------	------	------	1.15

TABLE 3

MEASUREMENTS IN MILLIMETERS OF TEETH OF *Mytonolagus* NEAR *M. petersoni*

	Number	Observed Range	Mean
P^2 a-p	12	0.88-1.36	1.09
width		1.18-1.76	1.54
P^3 a-p	5	1.59-1.76	1.72
width		2.37-2.71	2.54
P^4 a-p	9	1.73-1.93	1.84
width		2.03-3.52	2.63
M^1 a-p	12	1.63-2.00	1.85
width		2.10-3.86	2.80
M^2 a-p	6	1.56-1.90	1.74
width		2.14-3.25	2.64
M^3 a-p	6	0.95-1.36	1.23
width		1.36-2.10	1.73
P_3 a-p	6	1.70-2.30	1.97
width trigonid		1.15-1.56	1.37
width talonid		1.12-1.66	1.35
M_3 a-p	9	1.36-1.73	1.57
width trigonid		1.25-1.56	1.37
width talonid		1.02-1.36	1.19

Mytonolagus and other late Eocene lagomorphs

Within the upper Eocene localities along Badwater Creek there are now known two and possibly three levels of development of *Mytonolagus*. The more westerly localities (5, 6, and 7) have produced the most primitive, a form slightly more advanced than *M. petersoni*. The more advanced *M. wyomingensis* occurs in the more easterly Wood Locality, and it, or a slightly more advanced form, is represented also at Rodent Locality. So far as known no *M. wyomingensis* is present in localities 5, 6, and 7, and no *M. petersoni* in Wood or Rodent localities. These forms, along with the Uinta Basin leporid *M. petersoni*, represent gradual stages of development within the late Eocene.

In addition to the late Eocene occurrences of *Mytonolagus* in the Uinta Basin and Badwater Creek, the genus has been reported from the Shoddy Springs local fauna of southwestern Montana (Black, 1967:62) and from Swift Current Creek, Saskatchewan (Russell, 1965:8-9). The Shoddy Springs *Mytonolagus* is represented by only a few teeth, which are smaller than those of *M. petersoni* but more similar to it in occlusal pattern than to *M. wyomingensis*. The Swift Current Creek lagomorph was referred by Russell (1965:8-9) to *M. petersoni*. Comparisons with the Uinta Basin specimens show, however, that in the Saskatchewan form the hypostria on the upper molar of NMC 8653 extends closer to the enamel limit than in *M. petersoni*. It differs from both *M. petersoni* and *M. wyomingensis* in having on P_4-M_2 of ROM 1679 the trignonid shorter anteroposteriorly relative to the talonid, which is more rounded lingually and reaches less far linguad, and in having a relatively longer lingual groove between trigonid and talonid. No little-worn P_3s are known for *M. petersoni*, but comparisons with P_3 of *Mytonolagus* near *M. petersoni* and *M. wyomingensis* show that on P_3 of the Saskatchewan form both the anterolingual fold and the more posterior lingual fold are situated more posteriorly than are the comparable folds in the specimens of *Mytonolagus*. Perhaps the more posterior lingual fold in the Saskatchewan forms marks the posterolophid of P_3. The Saskatchewan form is not yet known enough to serve as the basis for speculation. However, it is probably not referable to *M. petersoni*, and possibly not even to *Mytonolagus*. The characters of its lower cheek teeth are somewhat similar to those of some relatively primitive lagomorphs like *Desmato-*

lagus vetustus of the Mongolian Oligocene. In *Shamolagus medius* of the Mongolian late Eocene the folds on P_3 seem similar in position to those on P_3 of the Saskatchewan form. The Saskatchewan lagomorph suggests greater diversity in late Eocene North American lagomorphs than has been suspected, and although the evidence is not yet sufficient, it seems to have a few characters found in some of the Asian late Eocene lagomorphs and possibly in some later Tertiary North American lagomorphs that have been referred to as "*Desmatolagus*." The late Eocene lagomorphs of China and Mongolia (Burke, 1941; Li, 1965) form at least two groups, that of *Lushilagus* and its relative *Shamolagus*, and that of *Gobiolagus*. Of these, the former group is the more generalized and probably led toward *Desmatolagus* of the Oligocene. *Gobiolagus* is specialized in its strongly developed unilateral hypsodonty and relatively small talonids, and seems to have persisted into the Oligocene. *Mytonolagus* cannot be tied closely to either of these groups and appears to be more advanced toward later North American leporids in the proportions of its cheek teeth. The Saskatchewan form is more advanced in the proportions of one tooth to another than are members of the Asian *Lushilagus-Shamolagus-Desmatolagus* group. However, the Saskatchewan form shows a little greater resemblance to that group than does *Mytonolagus*.

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VOLUME 41 ANNALS OF CARNEGIE MUSEUM ARTICLE 8

FOSSIL FISHES FROM SOUTHWESTERN PENNSYLVANIA

Part I: Fishes from the Duquesne Limestones (Conemaugh, Pennsylvanian)

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INTRODUCTION

The excellent exposures of Conemaugh, Monongahela, and Dunkard group rocks in and around Pittsburgh, Allegheny County, Pennsylvania, have been the subject of a few sporadic searches for vertebrate fossils. Beds containing fish scales and teeth were reported as early as 1876 (Stevenson, 1876: 78, 326). P. E. Raymond (1910) noted the presence of bone in the Ames limestone and underclay and in the Birmingham shale. E. C. Case (1915) described some tetrapod remains from Pitcairn, Allegheny County, and summarized earlier vertebrate fossil finds from southwestern Pennsylvania. Moran (1952) and Romer (1952) discussed all vertebrate fossil finds previous to 1952 from the Pennsylvanian of Allegheny County as well as from the Dunkard of West Virginia and Ohio. Kent (1967) and Schweinfurth (1967) repeatedly mentioned the occurrence of fish remains in the fresh-water limestones of southwestern Pennsylvania. Fossil fishes below the Conemaugh are known from two famous localities: Linton, Ohio (Newberry, 1873, 1875), and Cannelton, Pennsylvania (Westoll, 1944), within 70 miles of Pittsburgh, but are seriously in need of restudy.

ACKNOWLEDGMENTS: I am grateful to Carla Hartz and Lee Ambrose, who have ably and enthusiastically illustrated this paper; W. S. Stephens, District Engineer, State Highway Department, for access to this locality; the Penn Central Company for permission to prospect along their right-of-way; Drs. Craig C. Black and Mary Dawson, Carnegie Museum; Dr. Keith S. Thomson, Yale Peabody Museum; and Dr. Bobb

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Geologic Setting

The Ames marine horizon of the central Conemaugh group marks a change in depositional history in this area from alternating near-shore marine and fresh-water sediments of the lower Conemaugh, to the predominantly, if not exclusively, fresh-water beds of the upper Conemaugh, Monongahela, and Dunkard groups. Fossils useful for correlation above the Ames limestone are plants, ostracods, and insect wings. Zonation of the Pennsylvanian-Permian section of western Pennsylvania is based chiefly upon plant successions (Darrah, 1934), coupled with classic applied stratigraphic principles. Little use has been made of the invertebrates, and no use of the vertebrates.

The presence of cyclical deposits throughout the Pennsylvanian and Permian of southwestern Pennsylvania indicates repetition of varied ecological and depositional conditions. A typical cyclothem in the Pittsburgh area consists of several elements. A clay zone, representing soil formation, contains scattered plant material. A carbonate zone which may contain a few teeth and denticles of *Orthacanthus*, and an occasional microsaur tooth, may occur in the clay. These carbonates thus seem to represent local flooding or standing-water conditions. Fresh-water limestone may be developed within the clay zone, usually locally. Overlying the clay is either coal or a trace of coal, with plant material only. The coal is usually succeeded by a jet-black, carbonaceous and pyritic shale, either massive or very thin-bedded, and of fresh-water origin. Massive shales may have occasional scattered fish material, while thin, evenly-bedded shales may contain many fish scales and occasional articulated vertebrates, as well as pieces of plant stem and leaf. This thin black-shale zone grades upward into gray, flaky shale, irregularly bedded, containing plants, insect wings, and conchostracans, seemingly representative of very shallow-water, mudflat facies. Above this zone lies a thick zone of plant-containing, light-gray silts and interfingering sands, upon which another clay zone is developed.

Fish remains occur, broadly speaking, in two different sedimentary types representing strikingly different ecologies. The most readily observable remains occur in the jet-black, carbonaceous siltstones and shales that frequently accompany coals or coal zones. Bones, scales,

teeth, and spines of fish, filled with pyrite, are accompanied by coprolitic material and, much more rarely, by articulated specimens or portions of specimens. Fish scales occur irregularly throughout the black shales and may be locally concentrated. Tetrapod remains are rare to nonexistent. Fresh-water limestones may contain local concentrations of fish and tetrapod remains, under somewhat specialized sets of depositional circumstances that are not well understood. Fossil vertebrate specimens, furthermore, are almost never found articulated in these limestones. While it is not unusual to find small numbers of fish teeth and scales in fresh-water limestones, only rarely are sufficient concentrations of material found to be of any paleontologic use.

Stratigraphically useful invertebrate fossils are rare. But many horizons contain fossil-fish material, and it may be possible to correlate units on the basis of their vertebrate faunas when the latter are known well enough. This paper is a preliminary report on a few fresh-water fossil fish from one of these horizons, the Duquesne limestone.

The following abbreviations are used throughout: AMNH, American Museum of Natural History; CM, Carnegie Museum; DL, Duquesne limestone; CMSL, Carnegie Museum Stratigraphic Locality, Section of Invertebrate Fossils; FMNH, Field Museum of Natural History.

DUQUESNE CLAY AND LIMESTONES

The Duquesne clay occurs between the top of the Grafton shales and the base of the Duquesne coal (Johnson, 1929). In places where the Grafton shales are cut out, the Duquesne clay lies directly on the Ames limestone (Johnson, 1929: 5). The clay averages about eight feet in thickness throughout Allegheny County and contains, in its upper portion, occasional well-preserved terrestrial plant fossils standing erect (CMSL 366).

A carbonate zone occurs near the center of this clay, generally poorly developed and unfossiliferous, but persistent. North of the bluffs of the Allegheny and Ohio rivers, the carbonate zone appears in three layers of fresh-water limestone. They are dark gray to black, weathering to tan on a fresh break, and have a peculiar, foul, swamp-like odor when crushed or in contact with acid (White, 1878). Broad slabs exposed along McKnight Road, Ross Township, show many unrecognizable fragments of bone on their surfaces.

To my knowledge, the Duquesne limestones occur in only one area south of the Allegheny River, namely the west end of Mount Washing-

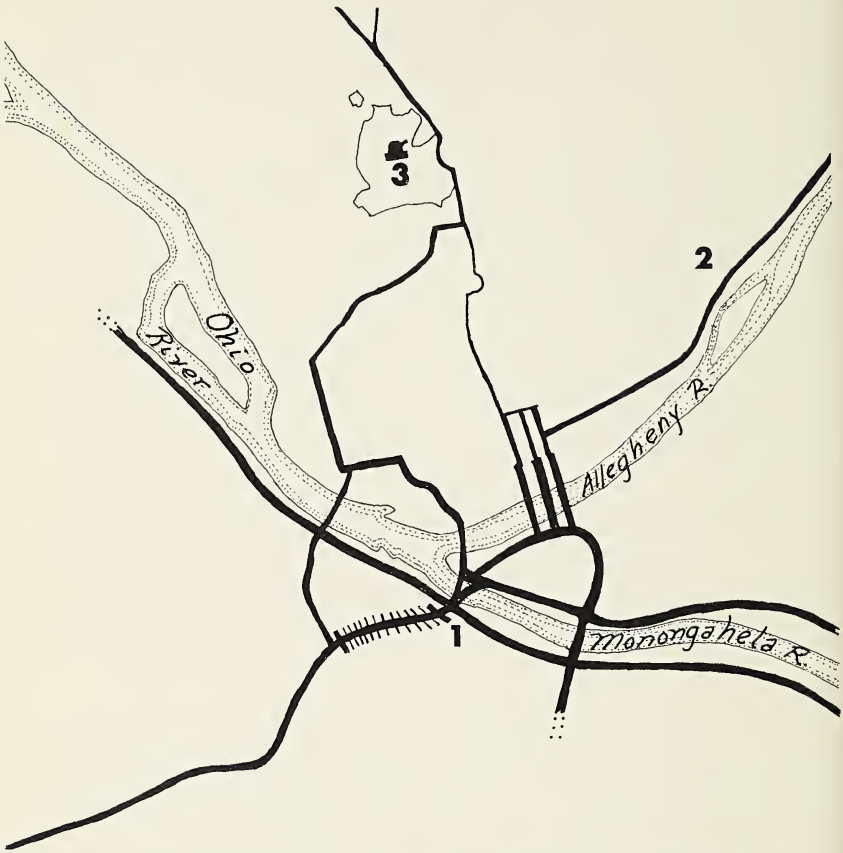


Fig. 1. Outcrops of Duquesne limestone within the city of Pittsburgh, Pennsylvania. 1. At the north portal, Fort Pitt Tunnels; 2. North bank of the Allegheny River, opposite Herr's Island; 3. Riverview Park, 100 feet below Allegheny Observatory.

ton, within the city of Pittsburgh. In this area, limestones 2, 4, and 6 outcrop for almost a mile along the bluffs of the Monongahela River, and again for a short distance west of the south end of the Fort Pitt Tunnels (fig. 1). Limestone 2a, 3, and 5, however, seem to occur only for about 200 yards of outcrop east of the north portal of the Fort Pitt Tunnels. They represent small bays that extended southward from extensive marly lakes. The Duquesne limestones from this area have produced an extremely rich and varied vertebrate microfauna, part of which is described here, as well as many fragments of larger vertebrates.

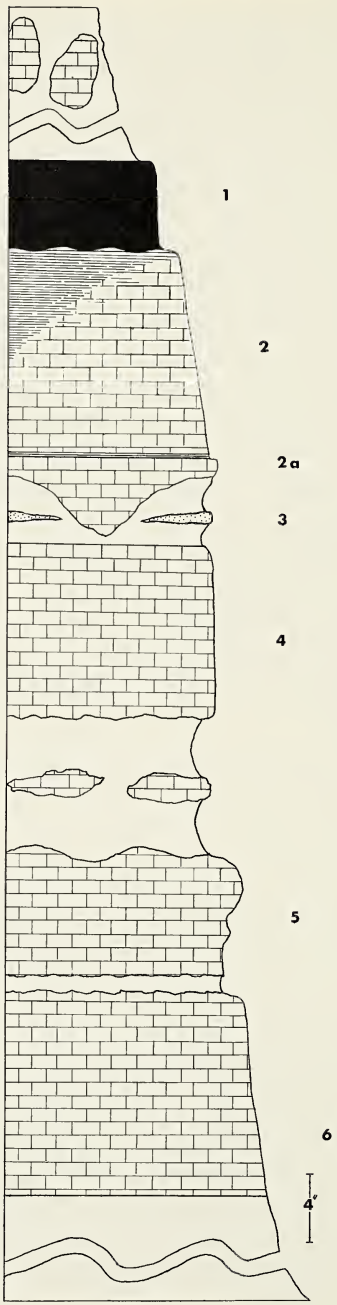
The invertebrate fauna is limited to ostracods, conchostracans, and *Spirorbis*. The outcrop of these limestones at the north portal of the Fort Pitt Tunnels is in a tall, slowly sagging, slump block.

Significant quantities of varied vertebrate material occur within and between the two top limestone units and in the lowest limestone. The sedimentary character of these units is worthy of more study than presently can be devoted to them. The upper unit (DL 2) grades into gray calcareous siltstone above as well at the east end of the outcrop. Scattered fish scales and teeth are found near the base of this siltstone. The limestone is distinctly conglomeratic, composed of dark and light lime pebbles and plates of siltstone in a calcareous and silt ground mass. The particle sizes are clearly larger toward the base of the unit, and most of the bone occurs in the lower inch of this bed. Bone occurs in all components of the rock unit, but is most common in the calcareous silt ground mass. There are associations of bony elements that indicate parts of individuals, but no articulated components. Non-carbonized but finely comminuted plant material is present throughout the unit. Fragmented tetrapod remains are common.

A very thin shale break provides an irregular plane of separation between DL 2 and DL 2a. This break, between $\frac{1}{32}$ inch and $\frac{1}{4}$ inch thick, has yielded scales, teeth, a partially articulated fish, and parts of a reptile.

Duquesne limestone 2a varies as greatly in composition as it does in thickness. In the thinnest parts, it is composed of thin plates of very light and very dark shale with calcareous cement. This unfossiliferous sediment may grade into either of two other types within a few inches. The more common type is a dark-brown limestone interrupted by frequent and seemingly random seams of calcareous silt. Small fossils are more prevalent in the silty fractions than in the limestones, while macrofossils are found in the limestones or crossing both silty and limestone portions. The remaining lithologic type is a massive, very dense, very black limestone with finely disseminated crystalline calcite. Macrofossils are lacking but fragmented microvertebrate fossils are common. Tetrapod material is almost totally absent in the lower of the two limestone units, and is limited to microsaur bones.

Duquesne limestone 6, averaging almost one foot in thickness, is a massive unit high in clay, locally high in iron compounds, and containing some gypsum crystals as well as an irregular mesh of calcite tubules, possibly from burrow fillings. *Orthacanthus* and *Xenacanthus* teeth,


1
2
2a
3
4
5
6
4'

paleoniscoid scales, and small tetrapod bones are irregularly distributed throughout and may be locally concentrated near the base of the unit. Lungfish remains are present but rare.

Transport of bone seems to have been significant in DL 2, but minimal in DL 2a and DL 6. Reworking of the unconsolidated substrate by burrowing organisms may have been the most important factor in disarticulating specimens in these units.

Deformation of bones prior to lithification can be seen in certain specimens from all fossiliferous limestone units. Small microsaurian vertebrae are generally skewed to one side. A large portion of an *Orthacanthus* spine was bent to the point of shattering individual longitudinal bony spicules. A large *Sagenodus* cf. *S. periprion* operculum was crushed from above, fragmented, and spread out to occupy almost twice its intact area. These examples, however, are exceptions, for most bones, large and small, show no trace of the effects of fossilization.

The distinctly fresh-water nature of the deposits is indicated by the presence of *Orthacanthus* sp., *Sagenodus periprion,* and another dipnoan, as well as by the several tetrapod remains.

The assignment of the name Duquesne limestone to these beds (Johnson, 1929: 60) recognizes their proximity to the overlying Duquesne coal and/or black shale. This stratigraphic proximity is deceiving, for the limestones occur in the midst of a clay representing a soil zone, a gap in deposition of unknown duration. At least one layer of erect, fossil land plants occurs between the definitive Duquesne coal horizon and the underlying limestone-coal sequence (fig. 2). The six-inch coal overlying the limestone sequence at the Fort Pitt Tunnels is not the Duquesne coal of Johnson (1929), which is represented by a trace at the base of the Birmingham shales at this place.

The elapsed time between the faunas of the Duquesne limestone and

Fig. 2. Outcrop of Duquesne limestone 100 feet east of north portal of Fort Pitt Tunnels prior to removal of layer 2a. At the top is a zone containing upright plant fruiting bodies. 1. Coal zone. Six inches of well-developed coal, underlain by soft gray siltstone. 2. Soft, laminated gray siltstone grades downward and laterally into a graded limestone conglomerate. Fossil vertebrates chiefiy near base. A thin shale break at bottom contains occasional bones. 2a. Limestone interfingered with shale. Variable in composition, very rich in bones. Underlain by clay-shale. 3. Thin, silicified layer, with occasional pleuracanth teeth, underlain by clay. 4. Thick. limy clay, with some fine silicate sand. Very few fossil vertebrates. Ostracods, *Spirorbis,* pleuracanth present. Underlain by clay. 5. Variably developed limy clay. No known fossils. Slight clay break underneath. 6. Thick, persistent layer. Limy clay mixed with areas richer in lime. Fossils in scattered concentrations near bottom of layer. Significant quantity of tetrapod material as well as a good representation of fish.

the overlying Duquesne shale may be significant. The time elapsed, however, in deposition of each of the two principal fossil-bearing limestones (DL 2 and DL 2a), is geologically very short. Neither bed shows any interruption or change in the nature of deposition vertically. Particle-size distribution suggests that DL 2 is a single, graded bed. Larger pieces of tetrapod bone are abraded and occur at the base of the bed, suggesting transportation of these chunks along with the plates of hardened silt. The small bones of fish and microsaurs are, for the most part, unworn and uninjured in spite of their great fragility. The remains of these aquatic vertebrates, found in the lime-silt ground mass, probably represent an *in situ* fauna. The peculiarities of this bed can be compared to a dried swamp bed flooded with silt-laden water.

DL 2a contained a major portion of the skull of one individual of *Sagenodus* cf. *S. periprion* (CM 19127). The bones were disarticulated but closely associated, and in some cases extended from the top to the bottom of the stratum. The bed itself is quite limited in area and probably represents the product of a single season of deposition of calcium carbonate in a shallow and algal-filled body of water .

Certain vertebrate elements in the fauna of the Duquesne limestones lend themselves readily to identification; others, such as the isolated paleoniscoid scales, cannot presently be treated.

SYSTEMATICS

Class Acanthodii

Family Acanthodidae

Genus *Acanthodes* Agassiz

Acanthodes cf. *A. marshi* Eastman, 1902

Certain fin spines found in the Pennsylvanian and Permian of south western Pennsylvania have been referred by Romer (1952:49) to *Acanthodes* cf. *A. marshi* Eastman. Neither spines nor scales are ornamented. Although spines and scales have been found in association (CM 21549, Fishpot, Monongahela group, upper Pennsylvanian), not enough is known of this form to render a valid comparison with *Acanthodes marshi* Eastman.

Class Elasmobranchii

Family Xenacanthidae

Genus *Orthacanthus* Agassiz, 1843

Orthacanthus Agassiz, 1837-1843.
Diplodus Agassiz, 1843.

Xenacanthus Newberry, 1856.
Orthacanthus Fritsch, 1889.
Xenacanthus Olson, 1946.
Xenacanthus Hotton, 1952.
Xenacanthus Romer, 1952.
Acondylacanthus Romer, 1952.
Orthacanthus Gluckman, 1964.
DIAGNOSIS: See von Fritsch, 1889: 100.

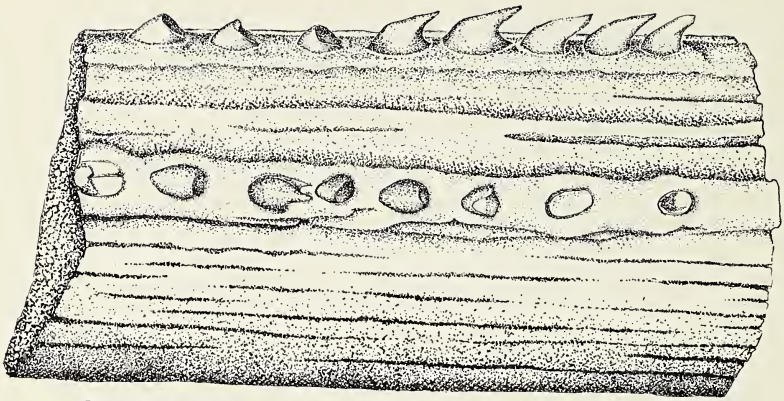
Orthacanthus compressus (Newberry)
Figure 3

Diplodus compressus Newberry, 1875.
Xenacanthus compressus Hotton, 1952.

DESCRIPTION: Several hundred teeth, ranging in height from ½ mm. to 3 cm., plus parts of two fin spines, have been found within the limited volume (5 cubic feet) of rock dissolved from DL 2a. These teeth, while varying in size and proportions of the two main cusps, are perfectly uniform in characteristics. Each tooth has two large, blade-like serrated cusps, and a tiny central, generally unserrated, cusp upon a prominent rounded base. The basal surface of the tooth is cupped for attachment to the jaw, and a prominent boss is present lingual to the cusps on the denticulated surface. The two major cusps are almost of equal size in teeth that seem to be from near the symphysis, while on other teeth there is progressive proportional difference in the height of the two cusps. This feature, together with strong angling of the smaller cus, seems to be indicative of teeth located far back along the jaws. The spines (fig. 3) rae rounded in cross-section, thick, composed of longitudinal bony fibers reflected externally as fine striae, and bear a double row of small, sharply downcurved denticles proximally along a cupped rear margin. No complete spines have been found.

DISCUSSION: Hotton (1952) suggested that only one genus (*Xenacanthus*) of North American pleuracanth shark is known. Gluckman (1964: 211-212) reproduced the superb illustrations of von Fritsch (1889). These illustrations (von Fritsch, 1889, figs. 173-175) clearly indicate that the teeth named *Diplodus* (Agassiz, 1843) are associated with the spine named *Orthacanthus* (Agassiz, 1843, pl. 45, figs. 7-9), while the spine named *Pleuracanthus* (Agassiz, 1843, pl. 45, figs. 4-6), which is a senior synonym for *Xenacanthus* (Byrich, 1848), is associated with distinctly different teeth built upon the same general plan as those of *Orthacanthus* (*Diplodus*).

Almost all reported North American pleuracanth teeth are of the *Diplodus* type, corresponding to the genus *Arthacanthus*. North American spines of the genus *Xenacanthus* have been uniformly assigned



3



4

Figs. 3-4. Fig. 3. *Orthacanthus* sp. Fragment of spine. CM 19131. Unit is 1 cm. Fig. 4. *Xenacanthus* sp. spine. CM 19133. Unit is 1 mm.

(incorrectly) to the genus *Orthacanthus* (Newberry, 1873, pl. 40, fig. 4, for example). True *Orthacanthus* spines have been assigned incorrectly to the "genus" *Acondylacanthus* (Romer, 1952: 51). North American *Xenacanthus* teeth are rarely reported and tend to be overlooked principally because of their small size.

In DL 2a, two robust spines of *Orthacanthus* accompany many teeth of comparable size. *Orthacanthus* teeth are also known from DL 2, 3, and 6.

Genus *Xenacanthus* (Beyrich, 1848)

Pleuracanthus Agassiz, 1843.
Orthacanthus Newberry, 1873.

Xenacanthus sp.
Figure 4

One almost complete spine, plus a fragment of a second spine of this genus, is known from DL 2a. Teeth associated with spines of this size and delicacy have not been found in the same bed. However, *Xenacanthus* teeth have been retrieved from DL 6 and are quite common in the Dunkard series of southwestern Pennsylvania.

The spine (fig. 4) is quite thin, evenly tapered to the tip, and bears a row of depressed, recurved denticles on each side nearly throughout its length. The spine is nearly oval in cross section distally where the denticle rows are borne midlaterally, and is more highly arched proximally along its presumed dorsal surface than its somewhat flattened ventral surface. The denticle rows are ventrolaterally placed near the proximal end.

The teeth of Duquesne limestone *Xenacanthus* are diminutive, and differ strikingly from those of *Orthacanthus*. The two major cusps are subequal in size, approximately twice the length of the central cusp, thin, and circular in cross-section throughout their length. The two major cusps each bear six to eight thin vertical ridges along their distal halves from *Orthacanthus* in lacking a prominent labial process. The lingual "button" is quite variable in development. Little angular deviation of the cusps from each other is present. There is no difficulty in distinguishing the teeth of *Xenacanthus* from teeth in the same size range of *Orthacanthus*. The spine of *Xenacanthus arcuatus* (Newberry, 1873, pl. 40, fig. 4) from Linton, Ohio, Upper Allegheny series, differs from the Duquesne specimen in having a concave ventral face. No differences in spine shape are known between Conemaugh and Dunkard *Xenacanthus* (to be reported on at a later date). It is not presently possible to make species assignments based on the small samples available.

Order Hybodontida
Family Hybodontidae
Genus *Hybodus* Agassiz
Hybodus allegheniensis, new species
Figure 5

Hybodont shark: Romer, 1952, p. 49.
Agassizodus variabilis Romer, 1952: 49.

DEFINITION: A small, fresh-water hybodont shark, distinguishable from others by the following characters: the teeth bear a robust central crown flanked by 2 to 3

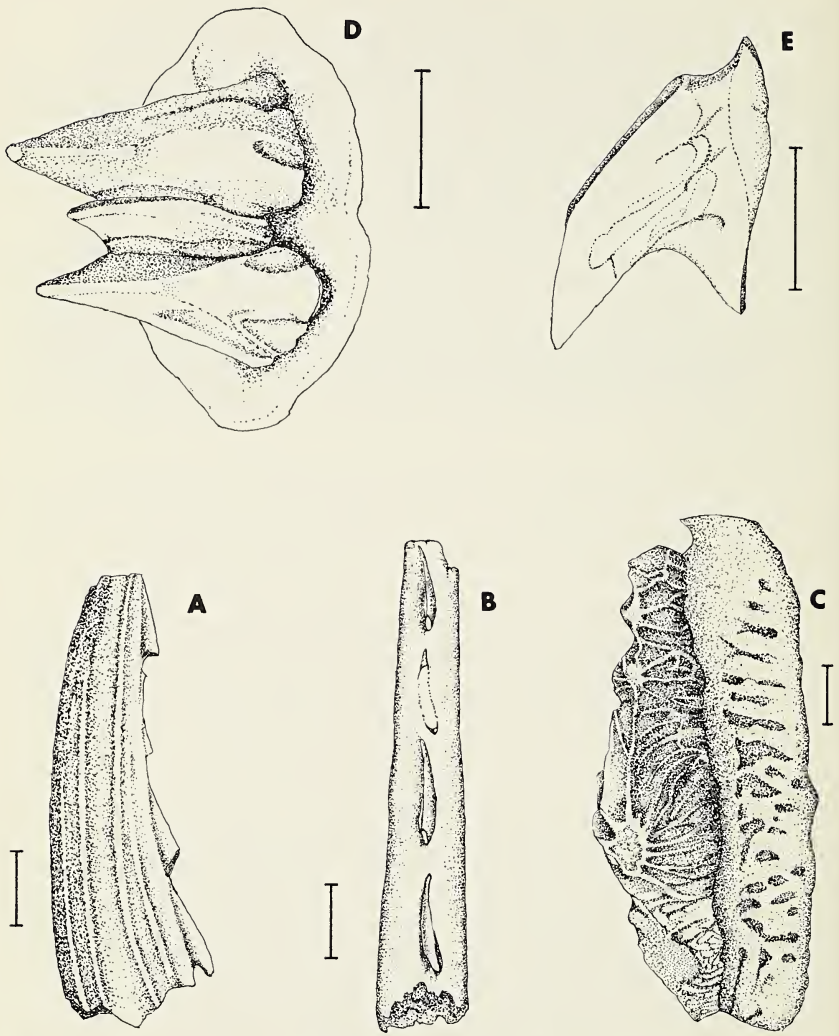


Fig. 5. *Hybodus* sp. A. Spine fragment, lateral view. B. Spine fragment, posterior view. CM 19134. C. Tooth, lingual view. CM 19135. D. Denticle dorsal view. E. Denticle, lateral view. CM 19136. Units = 1 mm.

progressively smaller crowns on each side; all crowns bear vertical, radiating crenulations, and a central ridge unites the cusps; tooth bases are produced inward into a strong roughened ridge. Denticles are large with a smooth, slightly convex internal surface, and an external portion consisting of two major lateral cusps and one to two smaller, central cusps, projecting backwards. The dorsal-fin spine is

greatly compressed, slightly curved and strongly tapering, ornamented with a few strong, narrow, longitudinal ridges laterally. Denticles along the posterior edge are directed basally, but alternately point to left and right, as do the teeth of a saw.

HORIZON AND LOCALITY: Duquesne limestone 2a, Conemaugh, Pennsylvanian, 200 feet east of north portal, Fort Pitt Tunnels; Pittsburgh, Allegheny County.

TYPE SPECIMEN: CM 19134, distal portion of a dorsal spine, Duquesne limestone 2a.

REFERRED SPECIMENS: CM 19136, dermal denticles; CM 19135, teeth, from the Duquesne Limestone.

A considerably broader spine fragment, equally severely compressed but showing more rapid tapering and no left-right alternation of denticle direction, comes from the Mason shale at Sample, Allegheny County. This spine (CM 21565) is regarded as a pectoral spine of the same "species" of hybodont shark.

DISCUSSION: The teeth originally referred to *Agassizodus variabilis* by Romer (1952) were, in fact, not related to the marine Pennsylvanian fish bearing the original name. The teeth and spine fragments mentioned by Romer are those of a fresh-water fish, and lack the broad, rounded cusps and the characteristic bradyodont structure of typical *Agassizodus* teeth.

Order Dipnoi
Family Ctenodontidae Woodward, 1891
Genus *Sagenodus* Owen, 1867
Sagenodus cf. *S. periprion*
Figures 6-9

Sagenodus cf. *S. periprion* have previously been described from the uppermost Conemaugh and the Greene of this region by Romer (1952: 52). Remains from DL 2a consist of two opercula, two tabulars, a parietal, parasphenoid, numerous cheek and snout bones, ribs, and right pterygoid and vomerine tooth plates, all pertaining to one individual (CM 19127). This specimen has an associated vomerine tooth (fig. 6), the first such tooth reported for this genus.

The forms of the cranial bones are apparently unchanged from the upper Conemaugh through the Dunkard and are relatively undistinguishable from the Texas Permian *Sagenodus periprion* (Romer, 1952: 54).

The vomerine tooth (fig. 6) is remarkable in its similarity to the form illustrated in figure 9 from the Duquesne horizon. Differences between these vomerine teeth are almost exclusively a reflection of the differences in size of the forms. The similarity between these teeth is in

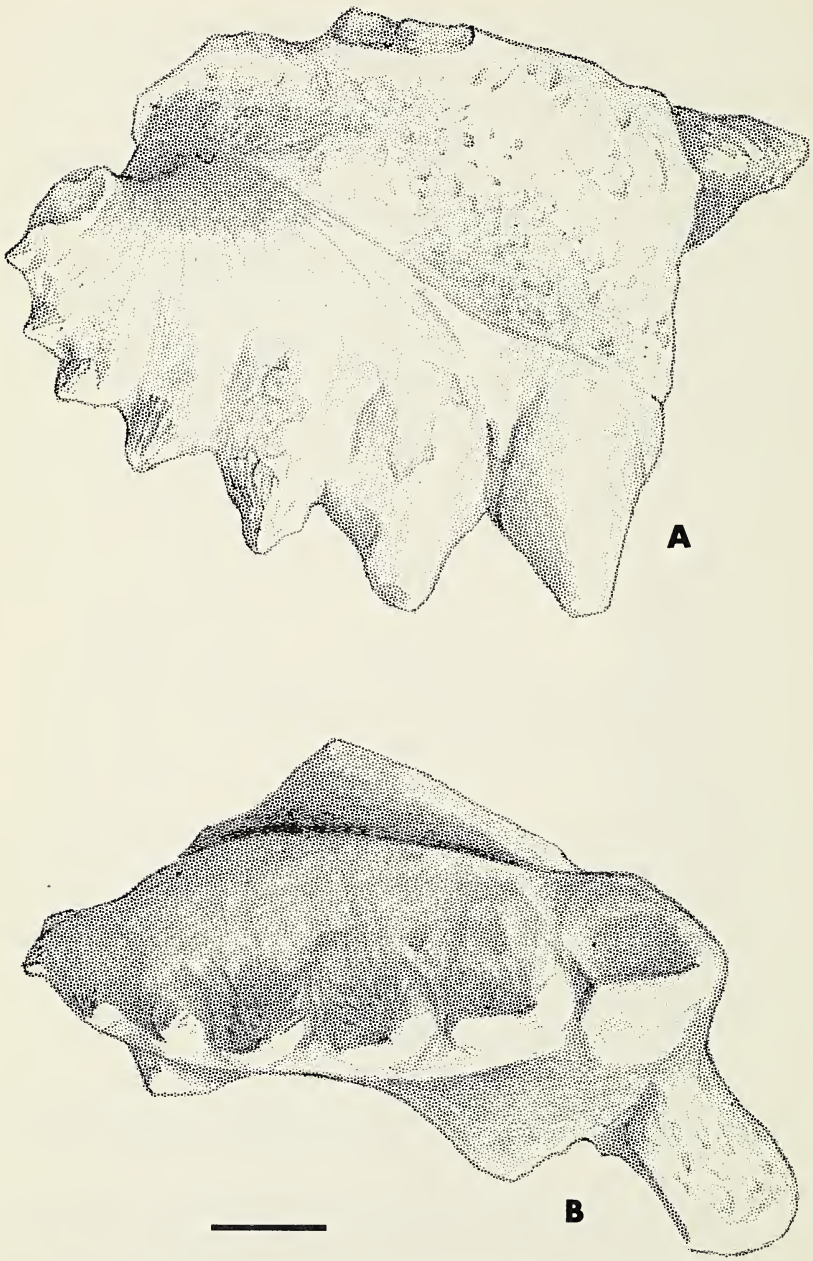


Fig. 6. *Sagenodus* cf. *S. peripron.* CM 19127. Left vomerine tooth. A. Anterior view. B. Ventral view. Unit is 1 mm.

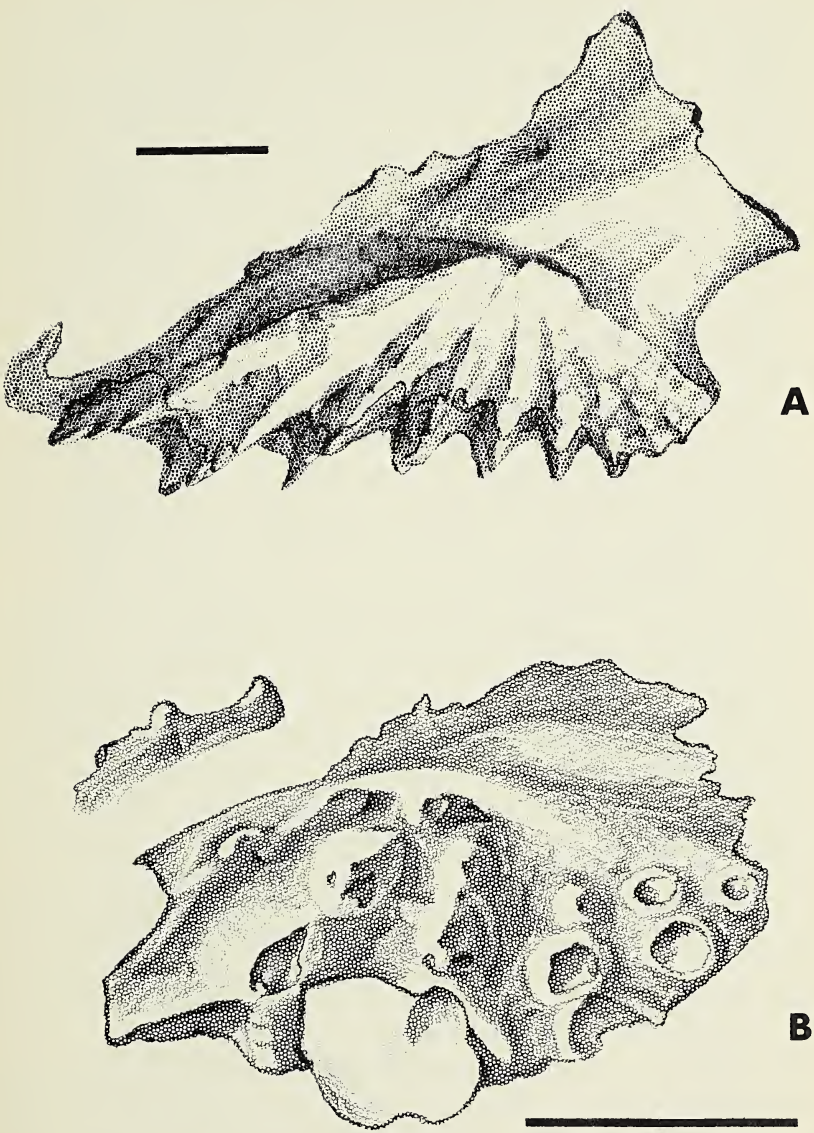


Fig. 7. *Sagenodus* cf. *S. periprion.* A. CM 19127. Right pterygoid, ventral view. Unit is 1 cm. B. CM 19469. Right pterygoid, ventral view. Unit is 1 mm.

strong contrast to the differences between the tooth plates of large (fig. 7A) and small (figs. 7B, 8) forms. The tiny vomerine teeth pro-

vided the first indication that a series of very tiny *Sagenodus* were preserved in the Duquesne limestone. This was confirmed only after a number of intermediate-size specimens were found in Monongahela- and Dunkard-group rocks. The latter specimens are currently under study.

EARLY GROWTH: The Duquesne limestone *Sagenodus* provide an insight into the ontogeny of the jaws of this form. The most immature specimen, CM 19465, bears four rows of teeth on a flat, simple, bony plate. The four rows contain five, five, five, and three, teeth respectively, beginning with the most anterior row, which measures 86 mm. in length. Each tooth in each row is almost double the size of the tooth mesial to it.

In CM 19471, the first row of teeth is missing, but the specimen bears a ventral ridge of bone that presumably lay mesial to Meckel's cartilage. The tooth rows show some fusion with growth of the individual teeth, so although there are five, four, and one, cusps respectively, the innermost cusps have been almost completely incorporated into the bases of the cusps next lateral.

CM 19467, which shows a well-developed ventral ridge, also bears a first cusp-row of 1 mm. length. It has four rows, bearing three, two, two, and two, cusps respectively. All traces of the tiniest mesial teeth have vanished, while the remaining teeth in individual rows have grown into hefty, wellrounded cusps united at the base. The most anterior tooth row maintains a sharply bladed series of cusps. In all three specimens where the first tooth row measures more than 1 mm., or where the spenial bone is well-developed vertically, there are four tooth rows, with a maximum of three cusps in each row.

CM 19468 (fig. 7) is the largest of the small Duquesne limestone *Sagenodus*, and the only specimen with five tooth rows. Evidence from Dunkard group specimens indicates that two additional cusps are added to each row before additional tooth rows are added to the splenial element.

One right palatal element is known that corresponds in size range with these splenials (CM 19469; fig. 7B). It is a broad, rounded element in a poor state of preservation which bears teeth or tooth bases indicating the presence of six rows. The most anterior row is compressed and blade-like, while teeth in succeeding rows decrease in compression, in tooth size, and in basal proximity. The superficial glossy layer of the teeth seems to extend at least across the anterior two valleys between tooth ridges. The remarkable thinness of tooth walls, dramatically

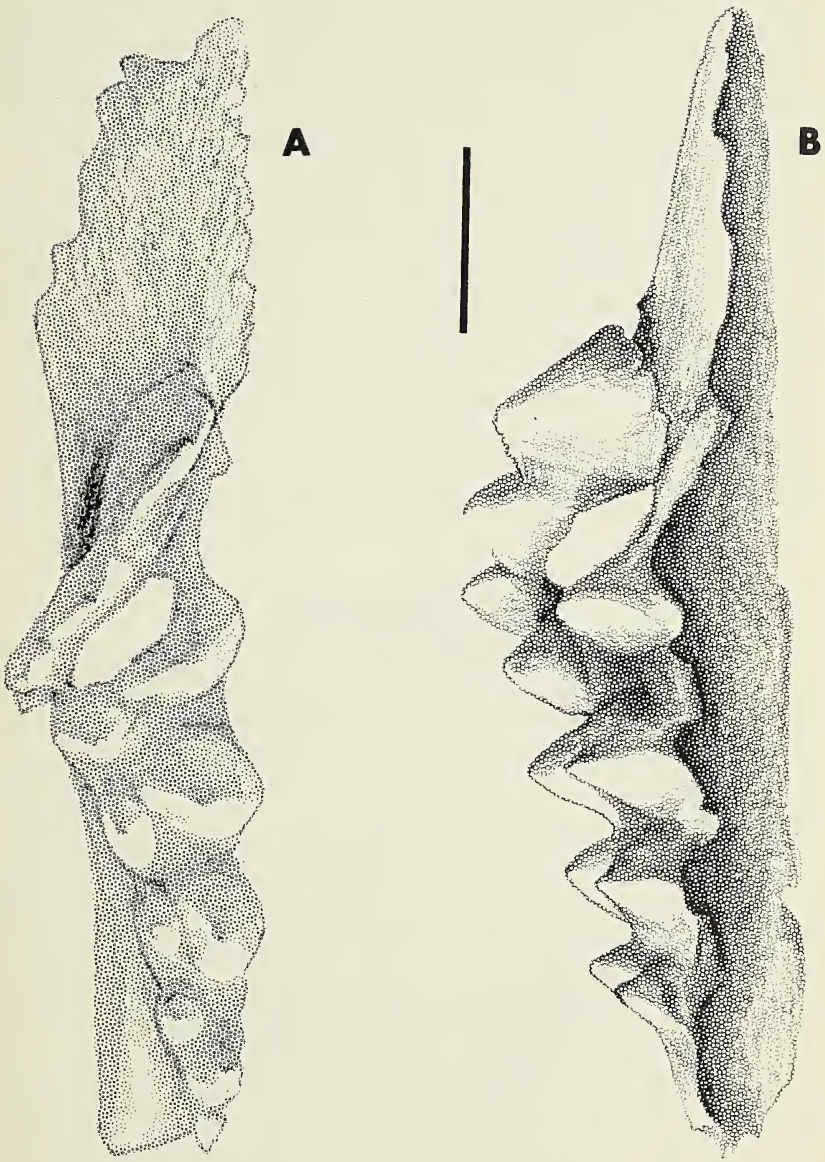


Fig. 8. *Sagenodus* cf. S. *periprion*. CM 19468. Right splenial. A. Dorsal view. B. Labial view. Unit is 1 mm.

illlustrated in this specimen, corresponds to the condition in several of the splenials.

The blade-like anterior ridge of the palate and splenial evidently were piercing and chopping ridges. The large, rounded, and yet thin-walled teeth of the posterior ridges seem incapable of masticating anything firmer than soft plant tissue or soft-bodied invertebrates. A generally vertical action of the splenial-dental ridges between those of the palate seems to be the only possible way of masticating.

The vomerine teeth assigned to this group (fig. 9) have been placed here on the basis of two observations. The first is that they closely resemble the vomerine tooth of *Sagenodus* cf. *S. periprion* (fig. 6), to which the tooth rows on the jaws also bear some resemblance. The second is the assignment of vomerines illustrated by Berman (1968) to *Gnathorhiza*, which, if correct, strongly suggests that vomerines such as that in figure 12 belong with a genus more closely related to *Gnathorhiza*.

Vomerine teeth of this size generally lack strong, bony bases. The bases, where seen, consist of highly spongy bone, spicular in construc-

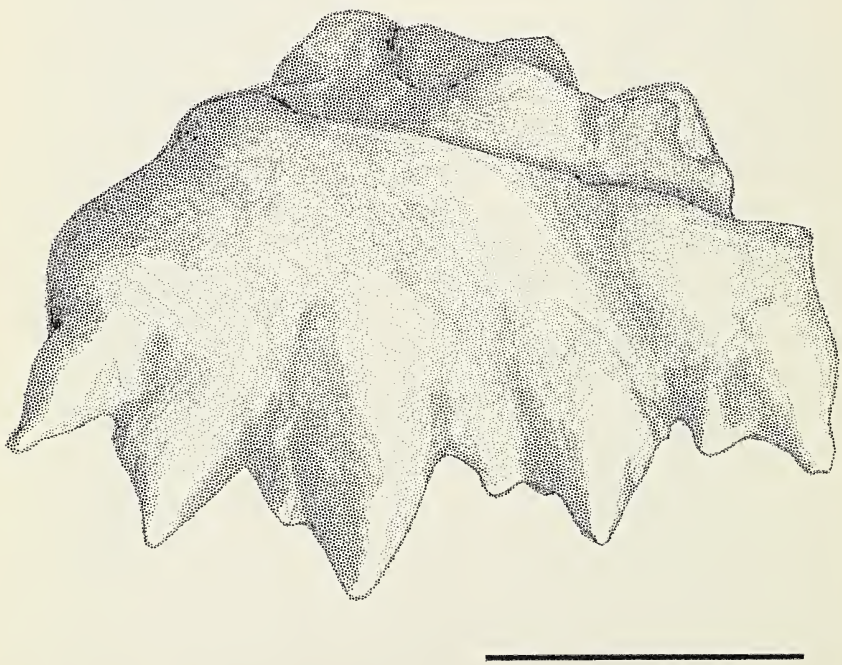


Fig. 9. *Sagenodus* cf. *S. periprion*. CM 19431. Right vomerine tooth. Anterior view. Unit is .25 mm.

tion and probably endochondral in origin. The teeth themselves vary only in the degree of development of secondary cusps, which are not constant in number, proportion, or size. Few cusps, gradually increasing in size away from the midline, plus a slight anterior convexity, describe this form. Only two features distinguish this vomerine from that of large *Sagenodus*: its minuscule size and a lack of evident wear on the sides of the more mesial cusps.

At the growth stages represented by the small *Sagenodus* specimens, there is no evident tooth wear. Addition of tooth rows and cusps with age is indicated in the Duquesne limestone *Sagenodus* where numbers of cusps per row is decreased by the incorporation of the smallest teeth into the bases of adjacent ones. Growth of individual teeth seems indicated, not only by this observation but by the tendency of larger splenials to have the teeth united at their bases, producing rows of cusps.

The small specimens of *Sagenodus* provides a remarkable insight into the ontogeny of this form.

Family Lepidosirenidae Bonaparte, 1841
Genus **Monongahela**[1], new genus
Type species: *Monongahela stenodonta*, new species

PROVISIONAL DIAGNOSIS: Lungfish, related to *Gnathoriza*, and known only from toothed elements recognizable on the basis of the following criteria: pterygoid element with four laterally divergent tooth ridges, the anterior three ridges divergent from an apex, the most posterior ridge originating lateral to the apex from the side of the ridge next anterior; all ridges slightly convex anteriorly; palatal bone broad and thin, not extending under lateral ends of posterior three ridges, and with a long horizontal symphysis; mandibular element with three tooth ridges divergent laterally, the anterior ridge longest, transverse ridge shortest, and originating posterior to apex of other two ridges; bone vertically developed with a posterior coronoid enlargement.

Monongahela stenodonta[2], new species
Figures 10-15

HORIZON: Duquesne limestone, Conemaugh group, upper Pennsylvanian.

LOCALITY: North face of Mount Washington, 200 feet east of the north portal of the Fort Pitt Tunnels, Allegheny County, Pittsburgh, Pennsylvania.

TYPE: CM 19450, right pterygoid element, from DL 2a.

REFERRED SPECIMENS: Mandibles CM 19412-19419, CM 19434-19442, CM 19445-19448, CM 19459-19461, CM 19473-19476, CM 19478-19484, AMNH

[1] Name is taken from the site where the first representatives were found, the bluffs at the mouth of the Monongahela River, Pittsburgh, Pennsylvania.
[2] From the extreme narrowness of the tooth rows.

4665; pterygoids, CM 19420-19430, CM 19449-19458, AMNH 4664; partial skull with two pterygoids and mandible, CM 19447; two mandibles and one pterygoid of a single individual, CM 19485; vomerines, CM 19433, 19487, 19488.

PROVISIONAL DIAGNOSIS: Lungfish of genus *Monongahela*, known chiefly from jaw elements. Jaw elements with cusps strongly flattened along axes of tooth ridges; cusps always united into distinct, separate ridges, with cusps becoming progressively less discrete with age. Pterygoid element with four ridges (a,b,c,d, anterior to posterior, fig. 12), angle ab plus bc usually equalling 90 degrees, angle cd with a mean of 30 degrees, range of 23-40 degrees, the angle decreasing with increasing individual age. Ridges a,b,c are all slightly convex anteriorly, and do not add cusps with increasing size, ridge d almost straight and adding cusps with increasing size. Lower jaw with three ridges (a,b,c anterior-posterior), angle ab with a mean of 48.6 degrees, range 25-65 degrees, median of 45 degrees; angle

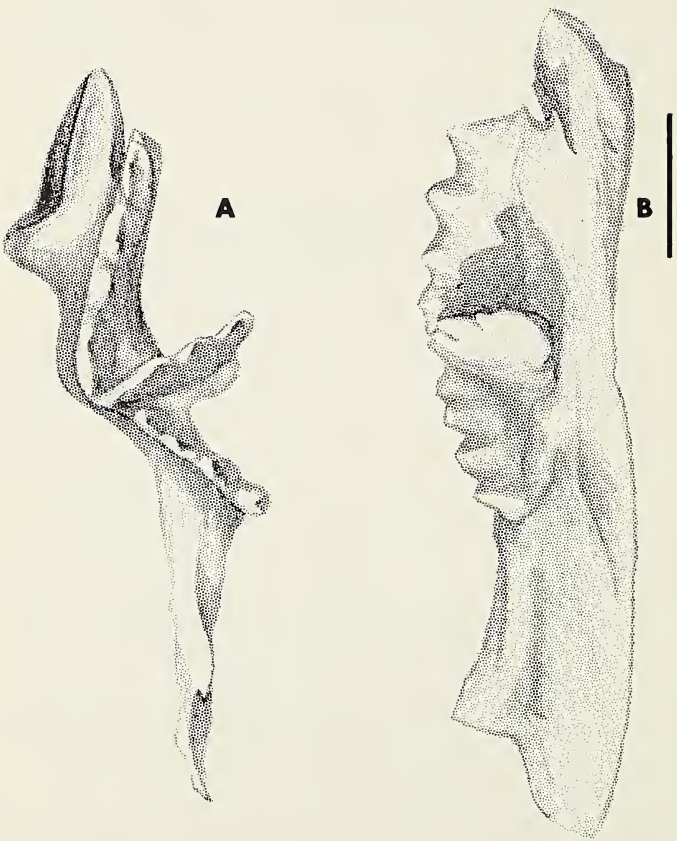


Fig. 10. *Monongahela stenodonta.* CM 19413. Right splenial. A. Dorsal view. B. Lateral view. Unit is 1 mm.

bc with a mean of 70.2 degrees, range 100-130 degrees, median of 115 degrees. Vomerines with over 10 small cusps and blade-like.

GEOLOGIC RANGE: Upper Freeport limestone, Allegheny series (=Westphalian of European section, Desmoinesian of Western North America), Pennsylvanian, through the lower Washington limestone member of the Washington formation, Dunkard group, Wolfcampian (?), Permian (?).

DISCUSSION: The jaws of small individuals of this species were very common in DL 2a, and were present in DL 2. One fragmented jaw was found in DL 6. Preservation was generally excellent; very few fragmentary jaws were found. Size variation is between 1 mm. total lower-

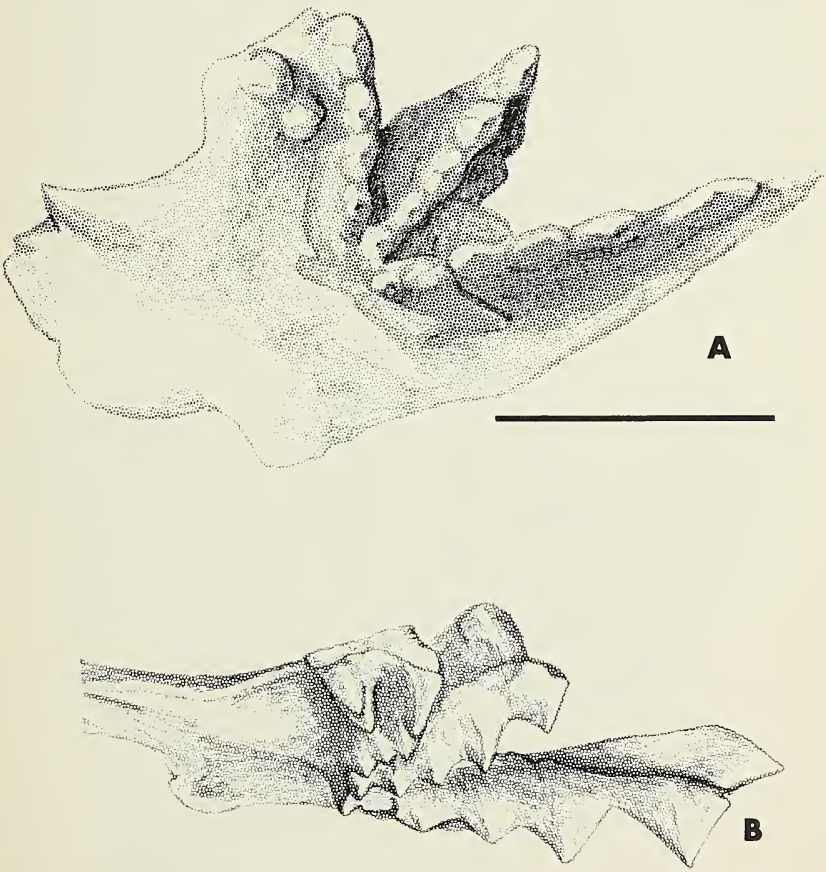


Fig. 11. *Monongahela stenodonta.* CM 19450, Type. Right pterygoid. A. Ventral view. B. Lateral view. Unit is 1 mm.

jaw length and 9 mm. total jaw length. One pterygoid (CM 19455) shows growth and wear indicative of a specimen much older than the others. Most of the remains seem to represent young specimens, possibly young-of-the-year.

The pterygoid plates (fig. 11) show an interesting pattern of growth of the various ridges, which sheds light on changes in feeding during the life of the fish. The three anterior-cusp ridges are extremely sharp-edged in the small specimens with indivdual cusps quite discrete although not isolated from each other. The number of cusps per tooth-ridge stays constant through growth of the animal until all cusps are obliterated by wear (fig. 13). The fourth cusp row consists of one relativley rounded cusp in the smallest individuals. Cusps are added with growth until the adult condition of the tooth plate is reached. At this point, the posterior ridge is of significant size, may contain up to seven cusps, and addition of cusp ceases. The three anterior ridges of the pterygoid are discrete in the young and meet at an apical cusp contributed by the central ridge. The posterior ridge is subsidiary to the ridge next anterior, originating on the side of that ridge (fig. 11). Growth of the ridges results in early union of the first three ridges at the apex, and considerably later in the incorporation of the fourth ridge.

There is little wear in juvenile *Monongahela* pterygoids. Slight wear facets are developed only at the tips of the cusps, and extremely sharp edges are maintained in valleys and all sides. There is no indication of shearing of upper against lower jaw and no means of crushing food items. The mode of feeding is almost certainly that of an active predator with teeth designed to pierce and hold prey.

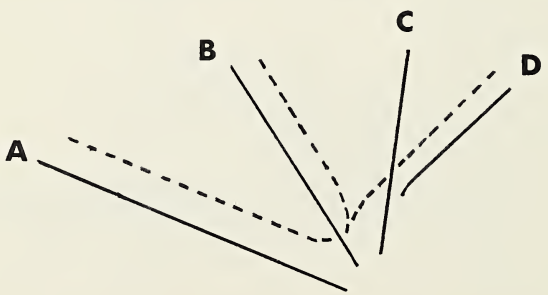


Fig. 12. Occlusal pattern in *Monongahela*. Solid lines represent pterygoid tooth ridges, dashed lines represent splenial tooth ridges. Ridges A,B,C, and D (pterygoid only) labelled from anterior to posterior.

With the achievement of a subadult size, as evidenced by growth of the fourth pterygoid ridge, aspects of wear become evident. Cusps gradually are obliterated by growth, from within and by abrasion, to form unified ridges. Ridges a and c, (see fig. 12 for key) united at the apex, are separated from b by a valley (fig. 13) produced by wear of the mandibular element, and a notch tends to be worn into ridge c by the mandible, generally lateral to the junction of c and d. The subadult shows a plate with one sharp, arcuate mesial ridge, composed of ridge a, the mesial part of c, and ridge d, plus two converging ridges separated from it, ridge b, and the lateral part of ridge c. Upon occasion, a specimen may be found where ridge c is notched mesial to its juncture with ridge d (CM 19455).

The change in ridge shape and relationship occurs when the jaw is relatively large. Therefore it is postulated that the change occurs at a subadult stage. The change results in a style of feeding better adapted to cutting and chopping. Both animal and vegetable material could be obtained and chewed with this mechanism.

The vomerine teeth attributed to this species (fig. 14) are rarely

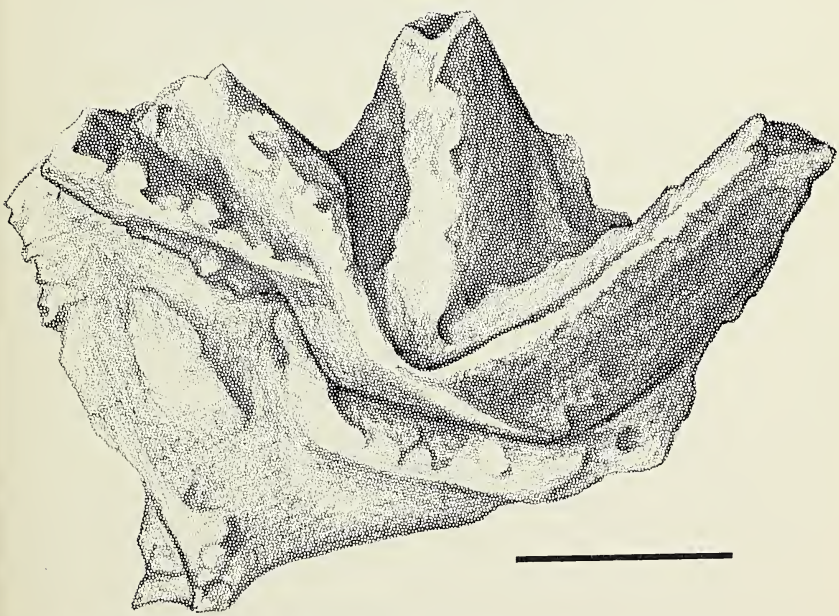


Fig. 13. *Monongahela stenondonta.* CM 19455. Right pterygoid. Ventral view. Unit is 1 mm.

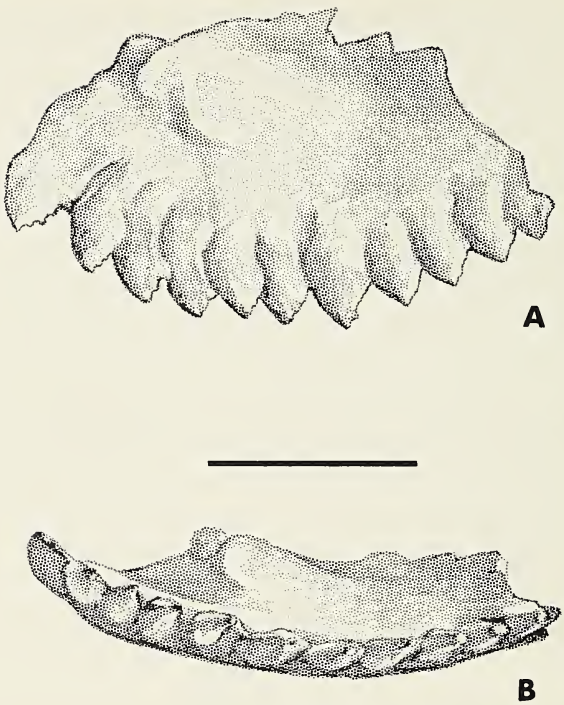


Fig. 14. *Monongahela stenodonta.* CM 19433. Left vomerine. A. Posterior view. B. Ventral view. Unit is .5 mm.

found, as they are tiny. They are blade-like, slightly convex anteriorly, and grow by addition of successively larger cusps laterally. Newer vomerine cusps are slightly serrated along their mesial edges. The older cusps show wear only on the mesial sides of their tips. As the vomerine teeth are not opposed by any known toothed elements, it is inferred that wear was produced by the action of tooth against prey, which suggests prey with a resistant external layer. The ostracods found in the same deposits would be within the size-range of prey for most of the *Monongahela* specimens represented.

The mandibular, or splenial, elements of *Monongahela* (fig. 10) do not differ noticeably from those of the Permian genus *Gnathorhiza* (Berman, 1968, fig. 2), except in size. The smallest specimen found, CM 19460, shows that: the anterior ridge a includes the apical cusp, ridge b (see Fig. 12 for key) originates from the cusp next posterior to the apex, and ridge c includes only the remainder of the cusps on a

line from the apical cusp. The separation between ridges is lost very early.

The range of angles found between ridges of the mandible is much greater than those of the relatively unvarying pterygoid. Bilateral variation is strong in CM 19485. The degree of latitude in lower jaw angles virtually prohibits accurate shearing action of the upper against the lower jaw and reinforces the belief that the feeding was accomplished by chopping and piercing. In the young, cusps served to hold, pierce, and cut prey, while older individuals lost the need for cusps, either as a result of change in the predator-prey size relationship or a change in diet.

The presence of single-bladed splenial elements in populations of Permian *Gnathorhiza* has been noted by Berman (1968). Single-bladed splenial elements comprise 19.5 percent of the total number of *Monongahela* lower jaws, and comprise a minimum of 16.1 percent of individuals sampled in this study. The size-range of single-bladed splenials is great. CM 19464 (fig. 14) is the largest splenial of any sort found.

These peculiar elements differ from normal *Monongahela* splenials in few ways. Most important, the transverse and posterior tooth blades are not present. The anterior blade is proportionally equal, in length, to the same element of a normal splenial. Shearing wear along the posteromesial half of the blade is evident (fig. 15) in all but the smallest specimens, as Berman (1968, fig. 2D) has illustrated for *Gnathorhiza*. No other acute differences are known and no palates that match this lower jaw have been found. Several specimens give some insight into a developmental peculiarity of high frequency and surprisingly great duration. CM 19461, a very small single-bladed splenial, displays one cusp oriented at an angle equivalent to the transverse blade, and one cusp oriented at an angle equivalent to the posterior blade. These two cusps are quite small, and are at the posterior end of the large anterior blade. CM 19464 bears one excedingly small, rounded cusp on its posterolateral edge. CM 19463 bears a slight posterolateral ridge. CM 19444 and CM 19476 each display two rudimentary cusps of the transverse ridge, and CM 19481 displays a rudimentary transverse ridge.

The single-bladed splenial is evidently produced through a reduction in the number of teeth in the posterior two ridges coupled with a lack of growth or exceedingly limited growth of the teeth that were present.



Fig. 15. *Monongahela stenodonta.* CM 19464. Right splenial, single bladed. Lingual view. Unit is 1 mm.

The anterior ridge is normal in shape, size, and position, but the splenial lacks a prominent "heel" to stop jaw travel by contact with the "heel" of the upper jaw. An abnormal, though functional, shearing action can thus take place between the anterior ridges of upper and lower jaws.

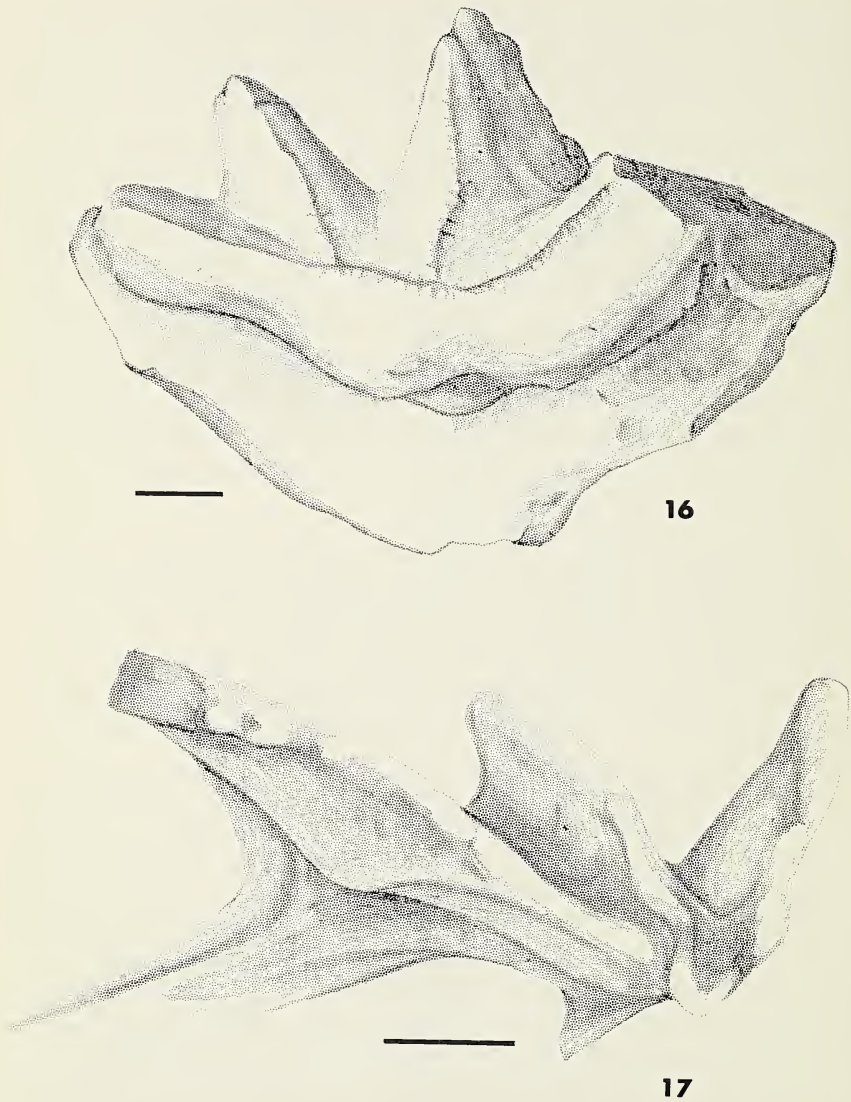
No palate has been found that would correspond to a single-bladed splenial in form or function, either in the Duquesne limestone or in the Permian Leuders formation (Berman, 1968). Berman has inferred that this type of splenial is simply an abberant lower jaw. When a specific change in dentittion of this magnitude, reflecting a relatively major change in jaw function and almost certainly in diet, can be demonstrated in high proportion over a considerable span of time and space, it is obviously an important biologic and ecologic factor. As the single-bladed splenial seems to arise through a developmental abnormality, it seems unwise to grant it separate taxonomic status at present.

Conclusions

Monongahela is clearly related to the Permian *Gnathorhiza* (fig. 16), differing chiefly in the interrelationships of the pterygoid tooth rows. Derivation of the *Gnathorhiza* palate may have been accomplished by a mesial shift in the point of origin of the most posterior tooth row, plus a spreading of the space between rows. Detailed treatment of this problem will appear in a later paper on some lower Dunkard *Monongahela.*

The *Monogahela-Gnathorhiza* group shows definite similarities to the very young *Sagenodus* described above. The blade-like anterior tooth row, and the tendency towards a blade-like second row in *Sagenodus* is quite reminiscent of *Monongahela.* The presence of only one more tooth row in *Sagenodus* jaws than in *Monongahela* jaws of the same size is an important addition to the similarities. At present, however, there are obvious barriers to a clear relationship between *Sagenodus* and *Monongahela.* Similarities exist only at the earliest ontogenetic stages of *Sagenodus.* As *Sagenodus* grows, it adds cusps and tooth rows, until at the adult condition it reveals basically different chewing motions, dietary adaptations, and ontogenetic patterns from *Monongahela.* Body form and skull bones are also quite different. Nevertheless, it is possible to conceive of an ancestral condition of *Sagenodus* from which both *Monongahela* and *Sagenodus* might be derived.

Contrary to the assertions of Berman (1968), there is a striking



Figs. 16-17. Fig. 16 *Gnathorhiza dikeloda*. FMNH UF 45. Right pterygoin. Ventral view, Unit is 1 mm. Fig. 17. *Protopterus annectans*. Right pterygoid. Ventral view. Unit is 1 mm.

similarity between the *Gnathorhiza-Monongahela* group and the recent lepidosirenians in cranial morphology (Olson, 1951), in habit (Romer

and Olson, 1954; Sterba, 1963), and in tooth-plate structure, development, and function. Two differences are conspicious.

The palate of *Protopterus* (fig. 17) has but three tooth blades, contrasted with four in Paleozoic forms. Further, the proportionally longest tooth blade is the most posterior rather than the most anterior blade. It has been shown, however, that the most posterior pterygoid tooth row of *Monongahela* is very short in small individuals and that it is late in developing. Further, suppression of splenial tooth rows is not unusual in *M. stenodonta* and *Gnathorhiza,* and is not an improbable mechanism by which the *Protopterus* pattern may have been derived. It may be pointed out that two small palates of *M. stenodonta* (CM 19420 and 19421) apparently lack a posterior-tooth row. Differences in proportional length of tooth rows between the Paleozoic and the Recent are to be expected.

The pterygoid bone of *Protopterus* is a vertically expanded element with little flattening under the tooth rows. The pterygoid bones of the Paleozoic genera are thin, flattened horizontal plates, somewhat extended under the tooth rows. The Recent fish appear to have strengthened the bony support for the palate considerably, a difference that is not anticipated in the Pennsylvanian fossils.

The diet of the Recent forms varies between small vertebrates and shelled invertebrates like snails and small bivalves (Sterba, 1963, p. 846). The tooth-blades, admirably suited to such a diet, are themselves substantially identical in form to those of the Paleozoic genera, and widely divergent from the crushing dentition of the ceratodont line and *Epiceratodus.*

Summary

The non-actinopterygian portion of the Duquesne limestone fish fauna consists of an acanthodian (microphagous?), two xenacanthid sharks (large and small predator), a hybodont shark (crushing-invertebrate feeder), a large dipnoan (scavenger-predator-herbivore) and a small dipnoan (crustacean feeder-predator). The actinopterygian portion of the fauna contains small, abundant secondary and tertiary consumers only.

Monongahela is a dipnoan approximating the ancestors of *Gnathorhiza,* and closely approximating the ancestor of the modern Lepidosirenidae. Although an ancestor for *Monongahela* is not known, the young stages of *Sagenodus* seem to be morphologically close to the necessary conditions.

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THE INFLUENCE OF PREHISTORIC MAN ON THE DISTRIBUTION OF THE BOX TURTLE

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Introduction

The Eastern Box Turtle (*Terrapene carolina*) has a wide distribution throughout eastern North America from Maine to Florida, and west to Texas. It is a common and conspicuous element of the fauna, but its distribution at the northern edge of its range has been difficult to determine, in part because this turtle is so often kept as a pet and then released beyond its natural range. This report is a re-evaluation of distributional records for this species from Wisconsin to Maine based on the large body of archeological data now available from this area. Accurate determination of the present range is prerequisite for a discussion of the various factors, including man, that have altered the distribution of this turtle.

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Fossil Records

Fossil material of this turtle is extensive, but is in large part only from two areas (Florida and Texas), both in the southern part of the range (Auffenberg, 1958, 1967; Milstead, 1969). Very few records are available from the northern part of the range that could give a clue to the distribution of this species during glacial and interglacial periods. Turtles like *T. carolina* are known from the upper Pliocene and Pleistocene of Florida (Auffenberg, 1958, 1967), and the Pleistocene of New Mexico, Texas, Kansas, Arkansas, and Missouri (Milstead, 1967). Although the box turtle still exists in most of Florida, the records from southern Texas, western Kansas, and eastern New Mexico, which are beyond the present range, suggest a more southern and western distribution limit during the Pleistocene. During this period or earlier, the Texas populations were doubtless in contact with others to the south in Mexico that now have become morphologically distinct and disjunct (*T. carolina mexicana*, *T. c. yucatana*, *T. coahuila;* Milstead, 1967). *Terrapene* is well known from archeological sites in Yucatan dating from the Pleistocene (Langebartel, 1953).

Fossil *T. carolina* are reported from only five localities in northeastern North America: two each in Pennsylvania (Fig. 1) and Virginia, and one in Maryland. Both Virginia localities are of late Wisconsin age: Natural Chimneys (Augusta Co.; Guilday, 1962b) and Early's Pits (Wythe Co.; Guilday, 1962a). The Maryland locality is Pleistocene in age (Talbot Co.; Milstead, 1965). The oldest Pennsylvania record is from Port Kennedy Cave (Montgomery Co.; Milstead, 1965), which is of Yarmouth age. Guilday *et al.* (1966) suggest a minimum date of about 1770 ± 200 years B. C. for the Bootlegger Sink *Terrapene* (York Co., Pennsylvania). The Bootlegger fauna contains both temperate and boreal elements and is undoubtedly the result of a long period of deposition. The box turtle, judging from its low fluoride content, was probably a late addition to the deposit. In contrast, the extensive excavations at New Paris Cave no. 4 (Bedford Co., Pennsylvania), dating 9345 ± 1000 B. C., failed to disclose this species (Guilday *et al.*, 1964), and it did not turn up at Frankstown or Cumberland caves, both Pleistocene assemblages (N. D. Richmond, pers. comm.). These records, although few in number, establish the presence of *Terrapene* as far north as southern Pennsylvania during at least some periods of the Pleistocene.

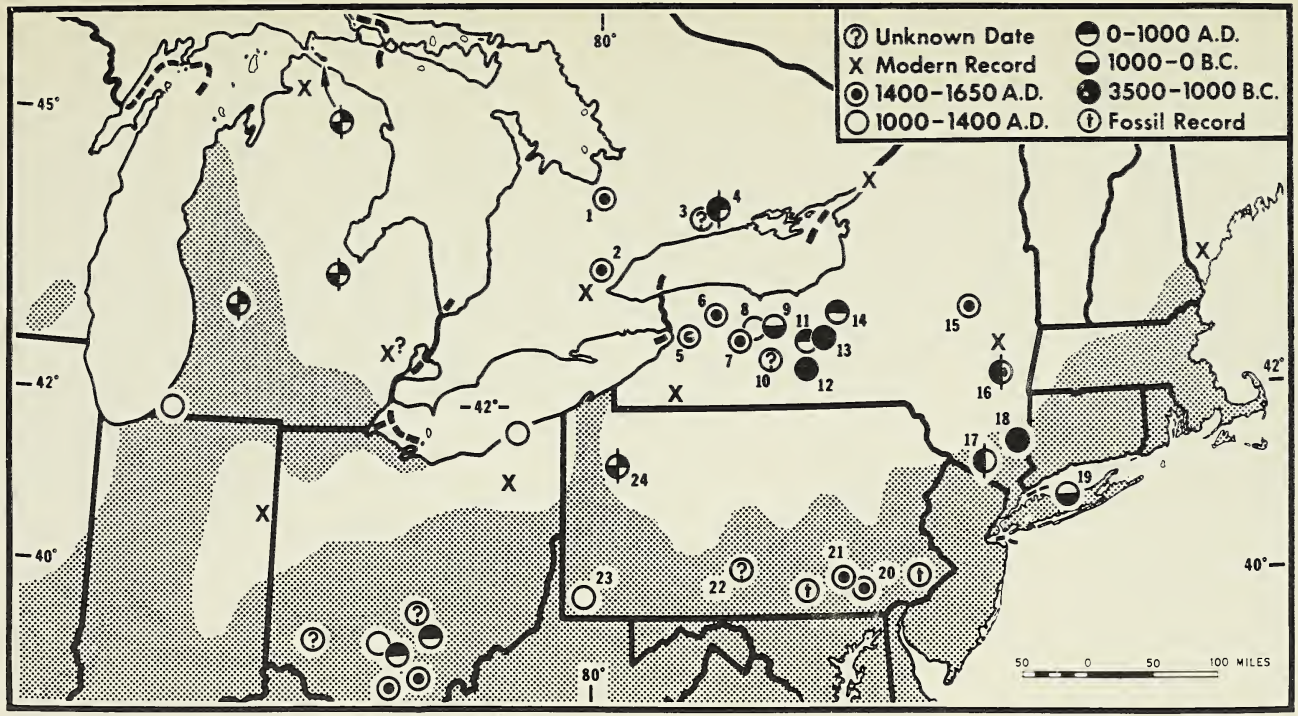


Fig. 1. Distribution of the Eastern Box Turtle (*Terrapene carolina*) in northeastern North America. Stippling indicates the modern distribution; single-specimen extralimital records are indicated by X. Archeological and fossil records are indicated by circles. Circles bisected by a vertical line represent multicomponent sites with occupations of two widely different ages. Numbers identifying sites refer to Table 1.

Archeological Records

Fossil and archeological records are listed separately, since prehistoric man occasionally transported turtles, including box turtles, and this means of dispersal must be taken into account. Archeological records for *T. carolina* in northeastern North America (Adler, 1968; table I, fig. 1) represent material from refuse pits or burial mounds. I have seen most of this material, and have particularly examined critical records.

TABLE 1

Archeological Records for *Terrapene carolina* in Ontario, New York, and Pennsylvania

SITE	COUNTY	DATES
ONTARIO		
1 Sidey-Mackay	Simcoe	1400- A. D.; 1591 A. D.
2 Lake Medad	Halton	1600 A. D.
3 East Gore	Northumberland	date undetermined
4 East Sugar Island	Northumberland	2000-1500 B. C.; 300 A. D.
NEW YORK		
5 Kleis	Erie	1620-1640 A. D.
6 Oakfield	Genesee	*1509 ± 150 A. D.
7 Dutch Hollow	Livingston	1590-1615 A. D.
8 Sackett	Ontario	*1140 ± 150 A. D.
9 Morrow	Ontario	*630 ± 100 B. C.; *563 ± 250 B. C.
10 Bristol Hills	Ontario	date undetermined
11 Kipp Island-2-3	Seneca	*310 ± 100 A. D.; *630 ± 100 A. D.
12 Lamoka Lake	Schuyler	*3433 ± 250 B. C.; *2575 ± 400 B. C.
13 Frontenac Island	Cayuga	*2980 ± 260 B. C.; *2013 ± 80 B. C.; *1723 ± 250 B.C.
14 Felix	Onondaga	500 A. D.
15 Garoga	Fulton	1550 A. D. (*1330 ± 100 A. D.)
16 Zimmerman Rockshelter	Greene	2200 B. C.; 1400 A. D.
17 Dutchess Quarry	Orange	2500-1500 B. C.; 1000-1400 A. D.
18 Vosberg	Dutchess	*2780 ± 80 B. C.
19 Stony Brook 2	Suffolk	*974 ± 250 B. C.; *944 ± 250 B. C.
PENNSYLVANIA		
20 Ibaugh	Lancaster	1400- A. D.
21 Eschelman	Lancaster	1400-1625 A. D.
22 Sheep Rockshelter	Huntingdon	date undetermined
23 Varner	Greene	1000-1400 A. D.
24 Quaker State	Venango	100 B. C.-900 A. D.

C-14 dates are preceded by an asterisk; others are estimates based on associated archeological material. In some cases, these dates may be accurate only for the *Terrapene*-bearing component. Dates are from Ritchie (1965) and Ritchie, Guilday, and Wright (pers. comm.). Numbers correspond to sites in Fig. 1; details for Michigan and Ohio records are in Adler (1968).

Box turtles (or "land tortoises, *Cistudo*" as they often appear in some of the archeological and older zoological literature) have been found at archeological sites in the northeast dating over the past five thousand years. The oldest record is from Lamoka Lake in central New York (site dated 3433 to 2575 B. C.). From then until about 1700 A. D. (Kleis,

Oakfield, Dutch Hollow, and Garoga sites) they were locally common in western New York, southeastern New York, and southern Ontario, areas largely beyond the present range of the species. In Pennsylvania all archeological records fall within, or only a few miles beyond, the present range (Fig. 1). Farther west, there are a few archeological specimens from beyond the present range in Ohio and Michigan, but in each case they were used as bowls and thus could have been introduced into these areas via inter-tribal trade. The two extralimital records from Michigan are each represented by a single fragment. These records and some material from Wisconsin originally misidentified as *T. carolina* are discussed elsewhere (Adler, 1968).

Box turtle artifacts are also known from four sites in southern Ontario (Table 1). In all cases, however, the specimens have been made into bowls or rattles, so the possibility exists that these may have been introduced via trade. However, one of these localities (Lake Medad; Bleakney, 1958) is very near the place where the single modern Canadian specimen was found (see below).

The archeological records indicate the widespread occurrence of the box turtle in northeastern North America since about 3000 B. C., and suggest a reduction of its range in New York and possibly Ontario since 1700 A. D. The possible causes of this reduction will be discussed in more detail below.

PRESENT DISTRIBUTION

Conant (1958) gives the most recent map for the range of the box turtle. After careful review of the literature and new records, and after consideration of each of these in view of the abundant archeological information now available (Adler, 1968; table 1), I have drawn up a new map (Fig. 1). There are significant differences between this and Conant's map, and these differences are briefly discussed below.

NEW ENGLAND

The box turtle ranges through the maritime provinces of New England to and including the southern tip of Maine. There are no records for Vermont. The only two records for New Hampshire are old (Huse, 1901), and both in the maritime part of the state. There is a single, old record from Maine (York Co., A. A. Barden, pers. comm.). Surveys in other parts of the state, including offshore islands, have not found it. However, box turtles are known from two islands off the Massachusetts coast: Martha's Vineyard (personal record) and Nantucket Island (MCZ

46174). Both islands were apparently separated from the adjacent mainland about 2000 B. C., according to botanical and zoological evidence (Ogden, 1958; Starrett, 1958). These two islands are located 5 and 20 miles, respectively, from the Cape Cod mainland. If these turtles did not swim these distances or were not transported by humans, this species has been present on these offshore islands (and presumably on the adjacent mainland) for nearly 4000 years.

NEW YORK, PENNSYLVANIA AND ONTARIO

Within historic times, the box turtle has never been listed as common in New York state except in the southeastern corner. Mearns (1898) said it was common along the lower Hudson River, from the Fishkill Mountains and Storm King Mountain (Putnam Co.) southwards. There are numerous records from Long Island (Latham, 1916) and Staten Island (Davis, 1912). Farther up the Hudson, there are two old records from near Albany (Eights, 1835; Baur *in* Taylor, 1895). It has apparently disappeared in that area since, as Bishop (1923) recorded no further specimens. The only historic record for western New York is a single specimen from Allegany State Park (Cattaraugus Co.; Eaton, 1945), although Bishop and Alexander (1927) did not find it in their extensive survey of the Park. Werner (1959) reported a specimen from Ironsides Island (Jefferson Co.), an island in the headwaters of the St. Lawrence River.

In Pennsylvania, *T. carolina* is not known from the northern half of the state, except along Lake Erie and near the Ohio Border. Since this turtle is not common at high elevations in mountainous regions, it seems unlikely that the western New York and Ontario populations of prehistoric times were derived from eastern New York, although the "Water Level Route" across central New York could have been used as an invasion route. It seems more likely that these populations reached this area via the low plains along the shore of Lake Erie, since the archeological records are more consistent with this hypothesis.

There is only one modern record for Ontario (and Canada), previously unreported, from 5.2 miles east of Alberton: "there was nothing about the turtle that might have led me to suspect that it had been a captive" (C. M. Bogert, pers. comm.). The proximity of this locality to an archeological site for *T. carolina*, namely Lake Medad, lends some support to the belief that this is a natural record.

OHIO, INDIANA AND MICHIGAN

The distribution of the box turtle in Ohio and Indiana is apparently not as continuous as currently thought. I can find only two seemingly authentic records for a broad belt of land from the Pennsylvania border to and including east-central Indiana. Dexter's (1955) record for Portage County, Ohio, was for a specimen actually collected in Carroll County farther south, and within the natural range of the species. However, his earlier record (Dexter, 1948) of a single specimen from Twin Lakes (Portage Co., Ohio) appears authentic. *T. carolina* is known from several Cleveland parks (Cuyahoga Co.) but these records are discounted since the species is absent from other areas beyond the city limits. *T. carolina triunguis* (a form found generally west of the Mississippi River) has also been taken in these same parks. It and *T. c. carolina* have both laid eggs there, and newly-hatched juveniles of both were found in the parks in 1959 (C. Strong, pers. comm.). Box turtles are absent on the Lake Erie islands (Langlois, 1964), although they are abundant on the adjacent Ohio mainland.

The only apparently authentic record for east-central Indiana is a single specimen collected in Adams Co. in 1953 (UMMZ 108078). Extensive collecting by many persons in this region and in the part of Ohio mentioned above has failed to turn up additional specimens. Actually, there is no fossil or archeological evidence to show that this turtle was ever native to this region. Today, this area is largely under cultivation, and the moist forests that *T. carolina* typically frequents have been reduced or eliminated. It is possible that the drying conditions of the Xerothermic Interval contributed to the demise of this turtle in these parts of Ohio and Indiana, if it ever occurred there at all.

In Michigan, the box turtle is known from the southwestern half of the lower peninsula. The most northern record along Lake Michigan is a specimen from Benzie County (UMMZ 108890) collected in 1953. There is only one record farther north, a single specimen collected during four summers of field work at Douglas Lake (Cheboygan Co.; Ellis, 1917), site of The University of Michigan's biological station. Continuous collecting in this region since that time has failed to turn up an additional specimen (F. H. Test, pers. comm.).

The northern distribution of the box turtle in Michigan (nearly to 45° North latitude) is of particular interest because it reaches only to about 43° North latitude on the Wisconsin side of Lake Michigan. Presumably, the temperature-moderating influence of the lake (caused by the high

specific heat of water) provides a more suitable climate on the eastern shore. The effective growing season is extended well into the fall on the eastern shore, which has resulted in a flourishing agricultural "fruit belt" in this region. In fall and winter, the temperature of the prevailing westerlies is often raised as much as 20° F. before these winds reach the eastern shore (Wills *in* Hambridge, 1941). In spring, the warm southwesterlies are cooled as they pass over the lake. The main effect is the delay of plant development — and perhaps emergence of terrestrial animals — until such time as the frequency of killing frosts is much reduced. Only a few of the terrestrial and aquatic vertebrates found on both sides of the lake show a more northerly distribution in Michigan. I do not have sufficient information on birds to comment on their distributions or times of migration on both sides of the lake. None of the fish or mammals shows a more northerly range limit in Michigan, except for a mole, *Scalopus aquaticus* (see Burt, 1964), but there are several examples among *terrestrial* amphibians and reptiles. The most striking instances are the box turtle, spotted turtle (*Clemmys guttata*), and Fowler's Toad (*Bufo woodhousei*). In fact, the northern limits of the ranges of these three forms are almost exactly the same east of the Mississippi River, even to minute details of distribution (compare ranges in Conant, 1958, Logier and Toner, 1961; Adler, 1968). In each of these, the distribution around Lake Michigan is alike, the range in Michigan extending nearly to the Upper Peninsula in the western part of the state along the lake. It is possible that these three forms have some similar sensitive point in their life histories that accounts for the resemblance in their northern distributions in this region. During the spring, they live in rather different habitats: *Bufo* in temporary pools and streams, *Clemmys* in permanent ponds and marshes, and *Terrapene* on land. The moderating influence of Lake Michigan would be expected to have rather different effects in each of these habitats. In the fall, however, the habitats of the three are similar, in that all are terrestrial. All three hibernate on land, including *Clemmys* (Netting, 1936). If a common limiting factor like temperature exists, the effects on the three species might be expected to be more uniform in the fall when all exist in similar habitats. I suggest that the absence of early killing frosts in the fall (in western Michigan as opposed to Wisconsin) might allow them a longer period in which to find a suitable site to bury themselves and successfully hibernate. Box turtles, for example, bury themselves in a slow, stepwise fashion requiring several days or weeks to complete. A killing frost or two in rapid succession could

kill such an animal before it could dig deep enough to effectively hibernate.

ILLINOIS AND WISCONSIN

In Illinois, Smith (1961) records *T. carolina* from the southern half of the state. There are no fossil, archeological, or modern records for the northern half.

The presence of this species in Wisconsin has been a matter for debate. Some authors (for example, Dickinson, 1965) have confused the eastern and western box turtle (*T. ornata*), and their records are thus useless. Higley (1889) reported two specimens of *T. carolina* from Walworth County, and Cahn (1929) mentions one from nearby Waukesha County. Both appear valid. It is doubtful that *Terrapene* were carried about and released in Higley's day as much as they are today.

DISCUSSION OF MODERN DISTRIBUTION

The modern limit of distribution for *T. carolina* from Wisconsin to Maine, as here understood (Fig. 1), is uneven. Its northward presence along the eastern shore of Lake Michigan may be due to the tempering effects of the lake, and its presence in maritime Maine and New Hampshire may be due to similar moderating effects of the North Atlantic. The absence of the box turtle in large portions of Ohio and Indiana, and in northern Illinois, may be due to effects of the dry Xerothermic Interval, although there is no fossil or archeological evidence to show that box turtles ever inhabited this area. The present limited distribution of this species in New York and Ontario, and its more widespread occurrence there in prehistoric times, seem not to be explained by any of these influences. The probability that some other factor is involved, namely man, is discussed below.

DISTRIBUTIONAL CHANGE IN NEW YORK AND ONTARIO

We must first consider the possibility that introduction of the archeological specimens of *T. carolina* was via inter-tribal trade, and that the species was never native to western New York or Ontario. This possibility is considered remote since specimens are present in large numbers at many widespread localities. In at least half these places they were used for food purposes, since unworked shells and limb bones, many of them charred, have been found in several New York middens. While it is possible that some of the worked material was introduced, it is doubtful that the Indians of this region would have imported turtles for food when

deer and other game species were plentiful locally. Indeed, the Indians of this area, particularly those of Late Woodland times, were noted for their independence and virtual lack of trade with outside tribes (Ritchie, 1965). It is true that seashells, shark teeth, Ohio flint, and other objects were imported via trade, but there were no substitutes for these items in western New York. Thus, the specimens of this turtle recovered from burials and middens are assumed to have been collected from resident populations.

Influence of Climate

Changes in the ranges of organisms over time periods are often explained on the basis of climatic factors, especially when there are coincident changes in the ranges of different forms. A unique change in a single species' range, like that which has occurred in the instance of the box turtle, is more difficult to explain. Today, the box turtle is found in three regions (Wisconsin, Michigan and New England; Fig. 1) at more northerly latitudes (above 42°) than those in which it occurs in New York. There are no obvious climatic factors, either now or since the Pleistocene, that would simultaneously explain the absence of these turtles in New York state, where they once occurred, and their presence elsewhere at more northern latitudes. The possible tempering effects of large bodies of water may account for the presence of box turtles so far north in Michigan and New England. Why then are these turtles absent today around other large bodies of water such as Lake Ontario (where box turtles once occurred)? Box turtles may well have entered New York during the warm, moist Climatic Optimum, as Guilday (*in* Ritchie, 1965) suggests. The later Xerothermic Interval, with its dry, prairie-like conditions, may have been instrumental in eliminating this turtle from certain parts of the Midwest, but probably did not affect populations farther east in New York. This turtle persisted in New York long after the termination of the Xerothermic Interval.

More gradual climatic changes also do not seem to be implicated as a cause for extinction in western New York. A comparison of pollen profiles from western New York (where box turtles disappeared) with those from New England (where the box turtle persists) suggests more dramatic changes in climate in the *latter* area. The time-span of interest is contained within the C-3 pollen zone, a sequence of deposition extending from about 100-0 B.C. to the present time (Davis, 1965). C-14 dates are not available from all profiles, nor is the C-3 zone equivalent in age at all sites under consideration. Nevertheless, the C-3 profiles are approxi-

mately of equal age and if they are not truncated, should give a view of floral (and climatic) conditions over this time period. An increase in the percentage of non-arboreal pollen, such as *Plantago* and Compositae, is assumed to indicate the effect of European forest clearance and, thus, a fairly complete, non-truncated C-3 zone. With these limitations, I have compared profiles in Vermont (Davis, 1965) and eastern New York (Cox, 1959) with those from west-central New York (Cox, 1959). None of these profiles appears to be truncated.

Since *T. carolina* is an inhabitant of open, deciduous woods (typically beech-maple; Stickel, 1950), particular emphasis is placed on the relative abundance of *Fagus* and *Acer*. Although hemlock is not commonly associated with *Terrapene* habitats in regions south of New England, this tree is a good indicator of moisture. It is present in all profiles considered here and is used to give a relative idea of moistness. In all profiles examined, the abundance of *Fagus* steadily decreases in C-3. In west-central New York (Bull Head Pond, Mud Lake-Tully, Perch Lake, McLean Bog), *Fagus* pollen gradually decreases in abundance, eventually reaching 35 per cent to 70 per cent of its maximum abundance in C-3. In eastern New York and Vermont (Mud Lake-Jordanville, Consaulus Bog, Chestertown Bog, Brownington Pond), *Fagus* also decreases in abundance, reaching 15 per cent to 40 percent of its maximum abundance in C-3. *Acer* pollen is less abundant in all these profiles but shows similar trends from west to east. *Tsuga* is more abundant and, in general, decreases in frequency during the C-3 zone.

These data suggest a warming and drying trend throughout the New York-Vermont region during the last 2000 years, but the trend is more rapid and pronounced in the East. If the box turtle is sensitive to such changes in climate, one would expect it to be most responsive in eastern New York and New England. Nevertheless, box turtles persist in the East and it follows that they would be expected to survive the apparently less drastic changes that occurred in western New York. Thus, it appears that such climatic changes were not directly responsible for elimination of the box turtle in western New York.

INFLUENCE OF MAN

A more plausible explanation for the box turtle's disappearance in the Lake Ontario region involves the relationship between these turtles and the Indians of this area. The box turtle was important to the Iroquois and certain cognate tribes, and the time and place of its elimination is closely correlated with the chronology of prehistoric cultural development in the

Lake Ontario region (Ritchie, 1954). Of all the Indian tribes of eastern North America, those of New York and Ontario had the longest and most intensive interest in box turtles. Judging from the burials and middens in New York state, predation on this species was intense and included both adult and juvenile specimens. At Archaic and Early Woodland sites (dating from 3500 to 0 B.C.), these turtles were used for food and as ceremonial objects as well, but mostly for the former purpose. At most sites where turtles were recovered, box turtle was the species most commonly eaten, although the amount of meat per specimen is far less than in several of the larger aquatic species. This use is in contrast to specimens from Middle and Late Woodland sites (0-1600 A.D.) where the majority were used in ceremonies.

The importance of the box turtle to Indians in the Lake Ontario region is particularly noticeable in the Iroquoian culture. *Terrapene* was the symbol of the earth or earth-bearer to the Iroquois and cognate Algonkian tribes. Consequently, it was much revered by them and was included among ceremonial objects in most burials, even those of women and children (Ritchie, 1954). Box turtles were used in many dances as ornaments and rattles (Ritchie, 1954), and in game-hunting to invoke the aid of the demons to capture prey (Fenton, 1941). In contrast, other Indian tribes of the time considered the turtle unimportant in religion or even despised the animal. Among the Indians in the western Great Lakes region, box turtles were rarely used in ceremonies; in many of these areas the aquatic Blanding's Turtle (*Emydoidea blandingi*) served this purpose (Adler, 1968). The Illinois and Miamis believed the earth was held up by an otter rather than by a "tortoise." Turtle eggs and small turtles were even considered a sign of bewitchment to the Hurons of Michigan and extreme western Ontario, although some turtles (but not *Terrapene*) were made into rattles and others occasionally used for food (Kinietz, 1940).

These Indians may also have affected box turtle populations in another, less-direct way. The popular belief that eastern North America was a continuous unbroken forest when the first Europeans arrived has been challenged by several recent authors (see Day, 1953). There can be little doubt that Indians, including the Iroquois, significantly altered these primeval forests. The Indians created large clearings for villages and agricultural fields. Their seasonal migrations and periodic relocation of villages extended their influence even farther. Women continuously foraged for firewood beyond the clearings and the men regularly fired the woods to drive game, to improve visibility for war purposes, and to

increase the supply of grass seeds. Such fires are typically fatal to terrestrial turtles and would be especially critical for juveniles with their less-protective shells. More important, perhaps, were the extensive clearings of land for cultivation of maize. The extent of these plots was often enormous, sometimes encompassing thousands of acres around a single village. The military expeditions into Iroquois country in the 18th Century often discovered large quantities of corn and grain. Sullivan's expedition in 1779 destroyed at least 160,000 bushels of corn in a series of small villages (Day, 1953). Thus, *Terrapene* were denied the use of a large portion of their former habitat since these clearings were usually made in forested valleys and lowlands.

The use of box turtles by New York Indians ended abruptly. As late as 1650 A.D., box turtles (and rarely the painted turtle, *Chrysemys picta*) were used as ceremonial objects (at the Kleis and Dutch Hollow sites, for example), but by contact times the Indians had switched to the snapping turtle (*Chelydra serpentina*), a large aquatic form. This species was relatively common in archeological material dating from the earliest times but was then used solely for food purposes until it came into ceremonial use about 1700 A.D. The earliest record of worked *Chelydra* comes from a single burial at the Pen Site (Onondaga Co., New York; P. P. Pratt, pers. comm.), a site that was destroyed by Frontenac's invasion, about 1685-1696. Morgan (1904) illustrates a snapping turtle rattle used about 1800. The Senecas of western New York still use *Chelydra* rattles today (Fenton, 1941, pls. 17, 20, 23, 24).

The timing of this substitution cannot be precisely determined. Box turtles have been found in graves at Dutch Hollow (1590-1615 A.D.) and several nearby sites dating from 1550 to 1687 A.D. (Rochester Junction, Dann, Power House, Feugle, Adams, and Cameron, according to C. F. Wray, pers. comm.; none of these is mapped in Fig. 1 but they are near locality 7). It is perhaps significant that the frequency of box turtles in these graves is much lower than at many earlier sites in this area. At Dutch Hollow, only 7 of 272 graves had box turtles (Ritchie, 1954) and at Rochester Junction, only 4 of 120 (Wray, pers. comm.). In addition, there is no evidence in these later excavations that box turtles were used as food, although they were commonly eaten as late as Oakfield and Zimmerman times (1400-1500 A.D.). This suggests growing scarcity of this turtle from 1500 to 1700 A.D. Some of the records of box turtles in the most recent gravesites could represent specimens that had actually been collected many years previously and made into artifacts.

It is possible that European man's agricultural activities had some additional effect since the first pioneers in western New York arrived about 1800 (Gordon, 1940). I consider this event less likely to be the cause of the turtles' disappearance than Indian influence, for two reasons. First, the box turtle populations were apparently already decreasing in size before 1700. Second, European cultivation in New England had seemingly not affected the box turtle populations there, at approximately the same latitude and at the edge of the species' range.

AMOUNT OF PREDATION

To anyone familiar with the high population densities of *T. carolina* in many regions it may seem naive to consider it possible that prehistoric man could be responsible for this turtle's elimination in a region as large as western New York state and parts of Ontario. But several facts should be considered. First, the Lake Ontario region represented, originally, the range limit for this species and, as is true for most organisms, the densities were probably reduced at the edge of the range where habitat is presumably less favorable. The box turtle was apparently never widespread in western New York, but rather localized in distribution and restricted to lowland areas. This is coupled with primitive man's steady, selective predation for 5000 years, becoming most intensive during recent Iroquoian times; there was a marked Indian population increase about 700-900 A.D. with the development of maize agriculture (J. B. Griffin, pers. comm.). I do not think it is mere coincidence that box turtles disappeared from precisely that portion of eastern North America where human predation was most intense, especially when these events are correlated temporally as well as geographically.

Fenton (1940) has estimated the population sizes of the various Iroquoian tribes at contact times, from which we can get a rough estimate of the amount of predation on box turtles for burial artifacts. These population figures are undoubtedly underestimates since European diseases and disruption of primitive economic patterns preceded the first observers (Day, 1953). The Five Nations of the Iroquois Confederacy, which occupied a part of western New York state, numbered at least 7000 persons when the first Europeans arrived (Fenton, 1940). If we assume that the population size was stable (including a stable age distribution) and further, that an average Indian lived 30 years, this means that 1/30th of the population, or 233 individuals, died each year. Although box turtles were buried even with women and children, not all

graves contain shells. Possibly many shells did not survive the ravages of decay (Ritchie, 1954). Nevertheless, except for the most recent burials, some individual graves had a dozen or more shells. If there was an average of one shell per grave, this means a predation of only 233 box turtles per year in this region, a relatively small number. However, this number represents only one type of predation on the box turtle. If we add to this (1) the predation of other contemporary tribes (Hurons, 30,000 persons; Neutrals, 12,000; Eries, 8,000-10,000, at contact times), at least in part of whose territory box turtles once lived; (2) the added predation among Iroquoian and cognate tribes for food, medical, ceremonial, and hunting purposes; (3) the sustained and selective predation on box turtles for some 5000 years; and (4) perhaps most important, the destruction of much of the turtle's original habitat, then the full effect of this predation and disruption of habitat seems evident.

Thus, present evidence suggests that the box turtle, an easily collected and especially sought-for species, was eliminated in western New York by the Iroquois Indians, a situation similar to the earlier Pleistocene extinctions of large mammals apparently perpetrated by man (Martin and Wright, 1967). The porcupine (*Erethizon dorsatum*) may likewise have been eliminated in Tennessee by Indians who prized the quills (Parmalee and Guilday, 1966). In contrast, the rice rat (*Oryzomys palustris*) took advantage of the spread of Indian maize agriculture to extend its distribution northward about 1000 A.D. (Goslin, 1951; Smith, 1965). All these cases point to the importance of primitive man in altering postglacial distributions of certain species.

SUMMARY

In northeastern North America, the range of the box turtle (*Terrapene carolina*) currently extends to central Pennsylvania, the lower Hudson Valley of New York state, most of Massachusetts, and into southern Maine. From 3500 B.C. until 1650 A.D., however, the range was more extensive in this area, extending up the Hudson Valley and including most of the western part of New York state and possibly southern Ontario. Evidence suggests that prehistoric man, primarily Iroquoian Indians, was responsible for elimination in these last-named areas.

Today, the box turtle is found in three areas at more northerly latitudes than those in which it occurs in New York: Wisconsin, Michigan, and New England. Each of these three areas had resident Indian populations, but unlike those in New York state, these Indians used box turtles only rarely. In western New York and southern Ontario, predation for food

and ceremonial purposes began as early as 3433 ± 250 years B.C. (Lamoka Lake site) and became most intense after 700 A.D. with the development of the Iroquoian culture. Burials, including those of women and children, sometimes contain up to a dozen specimens. Added to this was the predation for food, medical, ceremonial, and hunting purposes. Perhaps more important was the Indians' destruction of the turtles' habitat, primarily for cultivation of maize. As late as 1650 A.D. (Kleis and Dutch Hollow sites) box turtles were still in use, but by 1700, snapping turtles (*Chelydra serpentina*) had replaced them in burials.

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Volume 41 Annals of Carnegie Museum Article 10

EUPROOPS FROM THE "UFFINGTON SHALE" OF COLUMBIANA COUNTY, OHIO

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A nearly complete specimen of *Euproops laevicula* Raymond and the prosoma of a specimen of *E. danae* (Meek and Worthen) have been found in two large ironstone concretions in the dark fissile roof shales overlying the upper Freeport (No. 7) coal exposed in a strip mine, SE¼, SE¼ Section 19, Center Township, Columbiana County, Ohio. These are the first xiphosuran remains reported from the Pennsylvanian system of Ohio, although several specimens have been described from the Conemaugh and Allegheny groups of Pennsylvania, and their occurrence is of considerable stratigraphic interest.

Class ARACHNIDA
Subclass MEROSTOMATA Woodward
Order Xiphosura Gronovius
Family Euproopidae Eller
Genus *Euproops* Meek
Euproops danae (Meek and Worthen)

Plate 1, figure 1

Bellinurus danae Meek and Worthen, 1865, Proc. Acad. Nat. Sci. Philadelphia, 2: 44. Meek and Worthen, 1866, Illinois Geol. Surv., 2: 395, pl. 32, figs. 2, 2a.

Prestwichia danae Meek, 1867, Amer. Jour. Sci., 43: 257. Packard, 1886, Mem. Natl. Acad. Sci., 3(16): 146, pl. 5, figs. 3, 3a; pl. 6, figs. 1, 2a.

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Ann. Rept. (1883): 170, pl. 39, fig. 1. Raymond, 1943, Illinois State Mus. Sci. Papers., 3(3): 4-6, pl. 1, figs. 1-2; pl. 2, figs. 1-2. Raymond, 1944, Bull. Mus. Comp. Zool., 94(10): 484-486.

REPOSITORY: Carnegie Museum (CM 33060)

MEASUREMENTS: Maximum length of prosoma, 11.5 mm. Maximum width of prosoma at the base of the genal spines, 23.0 mm.

DISCUSSION: This species is so well known that no formal diagnosis is necessary (Raymond, 1944: 485). Although incomplete, consisting only of the prosoma, the specimen can be readily identified, for it possesses the rapidly tapering cardiac lobe characteristic of *E. danae*. *E. packardi* Willard and Jones has a similar cardiac lobe, but the prosoma is relatively wider. *E. packardi* is also described as having a rather strong posterior notch at the base of the cardiac lobe (Willard and Jones, 1935: 1277). This feature could not be discerned on a cast of the holotype from the Carnegie Museum collections (CM 23459).

The width/length ratio of the upper Freeport specimen is less than that of typical specimens of *E. danae*. The very short genal spines and the relatively small size of this specimen also suggest that it represents a young individual. The prosoma is unusually well preserved, only slightly wrinkled, with the ocelli prominent. The transverse bar at the midpoint of the cardiac lobe is also preserved.

Euproops laevicula Raymond
Plate 1, figure 2

Euproops laevicula Raymond, 1944, Bull. Mus. Comp. Zool., 94(10): 490, fig. 3.

REPOSITORY: Carnegie Museum (CM 33061)

DESCRIPTION: Cardiac lobe gradually tapering, prosoma narrow with a width/length ratio of 2.0. Thoracetron with nearly smooth lateral lobes, axial lobe with faint transverse furrows and nodes on the last several rings. Spines on thoracetron not preserved; genal spines short.

The prosoma of this specimen is partly obscured by the impression of a second specimen, though most of the features of the prosoma can be discerned. Diagnostic features of the second specimen cannot be determined.

MEASUREMENTS: Maximum length of prosoma, 11 mm. Maximum length of specimen (without telson), 20 mm.

DISCUSSION: The obscure transverse ridges on the axial and lateral lobes of the thoracetron are characteristic of this species. *Euproops laevicula* can be distinguished from the similar *E. parkardi* of the Allegheny group of Pennsylvania by the tapering cardiac lobe; that of *E. packardi* is like

the abruptly contracted lobe of *E. danae*. *Euproops packardi* also has a much wider prosoma and comparatively conspicuous transverse ridges

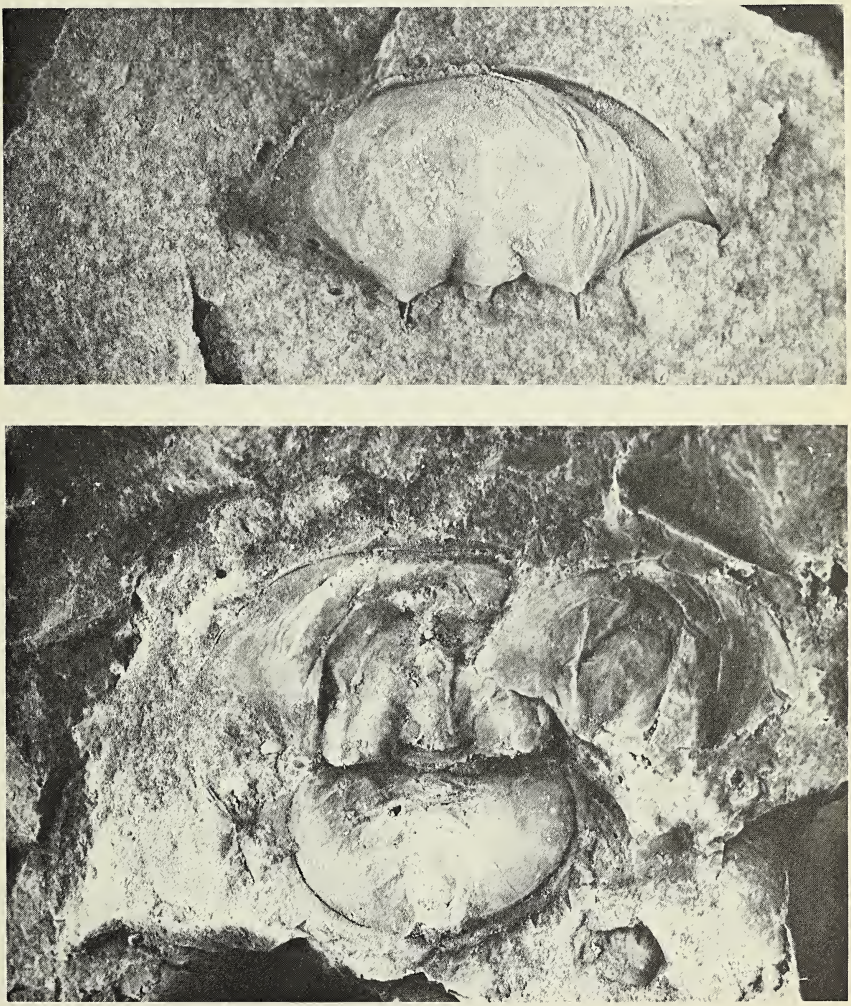


PLATE 1

Fig. 1. *Euproops danae* (Meek and Worthen); CM 33060. Prosoma from ironstone concretion. Upper Freeport coal roof shale, strip mine high wall, SE¼, SE¼ Section 19, Center Township, Columbiana County, Ohio.

Fig. 2. *Euproops laevicula* Raymond; CM 33061. A nearly complete specimen from the same horizon and locality.

on the lateral lobes of the thoracetron. The Ohio specimen may represent a slightly more mature individual than the holotype of *E. packardi* (CM 23459), for it has a longer thoracetron. *Euproops danae* can be distinguished by the presence of prominent transverse ridges on the thoracetron and by the abruptly tapering cardiac lobe.

Euproops darrahi Raymond of the Mason shale of Pennsylvania is probably a junior synonym of *E. packardi.*

This is only the second reported specimen of *E. laevicula.* It is of particular interest because of the close agreement with Raymond's original description. In a group like the Xiphosura, one should be extremely cautious in proposing new species. Considerable variation may be expected between individuals of the same species, fossil specimens are rare and usually distorted by crushing, and there is the further difficulty of molt stages and sexual dimorphism. Raymond might in fact be suspected of a needless proliferation of species based upon very slender evidence, arbitrary criteria, and often only single specimens. These two new specimens can readily be assigned to existing species within Raymond's scheme of classification. The conclusion to be drawn is that Raymond's classification, though artificial, is internally consistent, fairly conservative, and may suffice until a thorough, modern reappraisal of this group is undertaken.

The Upper Freeport Roof Shale Fauna

Associated fossils at the xiphosuran locality include the estherid *Cyzicus* sp., which has been found in both the black fissile shale and the ironstone nodules. The black shale also yields abundant ganoid (*Haplolepis*) and crossopterygian fish scales. Ostracods (*Candona and Gutschickia*) are also common in the nodules. A single blattoid wing has been identified by C. J. Durden as *Stygetoblatta.* A conspecific specimen has been found in the Mason shale of Pennsylvania (C. J. Durden, personal comm., Sept. 5, 1967).

Examination of other outcrops of the upper Freeport roof shales in Madison, Center, Hanover, and West townships reveals that the black fissile shale bed is widespread, with abundant ganoid scales and occasional *Xenacanthus* teeth. One fragmentary insect wing, identified by C. J. Durden as either *Mylacris* or *Orthomylacris* sp., has been found by R. Max Gard, Lisbon, Ohio, in an exposure along U. S. Route 30, NE¼ 24, Hanover Township, Columbiana County, Ohio. At this locality fossiliferous ironstone concretions occur sparingly, containing a few fresh-water ostracods. Estheriids (*Leaia*) occur in a section measured

by Stout and Lamborn (1924: 258) at West Point, Madison Township, and in a strip mine in West Township, though in both instances the unit is a silty shale overlying the black fissile shale. Normal marine fossils have not been found overlying the coal. With the exception of a Perry County locality cited by Sturgeon (1958: 92), where the brackish-water forms *Lingula* and *Orbiculoidea* occur sparingly, no brachiopods or molluscs are known from the beds immediately overlying the upper Freeport coal.

STRATIGRAPHIC DISCUSSION: The stratigraphic problem has been confused by recognition of a marine Uffington shale member that does not exist (Sturgeon, 1958: 92). Sturgeon failed to note that the marine Uffington shale of the type area, Morgantown, West Virginia, was long ago found to have been based upon a misidentified outcrop of the Mahoning coal and Brush Creek shale member. Nor did he note Price's (1917) redescription of the Uffington as a non-marine, plant-bearing shale immediately overlying the upper Freeport coal. A definite marine member overlying the upper Freeport coal would certainly deserve formal stratigraphic recognition, but the presence of two brackish-water brachiopod species at the Perry County locality is a poor foundation on which to erect a new marine member. The Columbiana County localities cited by Sturgeon (Stout and Lamborn, 1924: 238, 258) were originally described only as "fossiliferous," and collecting at these localities has shown that Sturgeon's belief that these fossils are marine is ill-founded.

If a marine zone were discovered over the upper Freeport coal, it could not be called Uffington, for that name belongs to the non-marine, plant-bearing unit of Price. Price's Uffington shale, incidentally, though recognized in the USGS lexicon, is probably deserving of no more than bed rank. The same is true of the black, fissile shale which is usually found between the coal and the Uffington shale or between the coal and the Mahoning sandstone member when the Uffington is absent. This black shale unit is presumably equivalent to units 2 and 3 of Cross's typical Dunkard cyclothem (Beerbower, 1961: 1031). Typical Uffington shale, as described by Price, and the black fissile roof shale bed are both present in Athens County, Ohio, but neither can be considered important enough to be termed a member.

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